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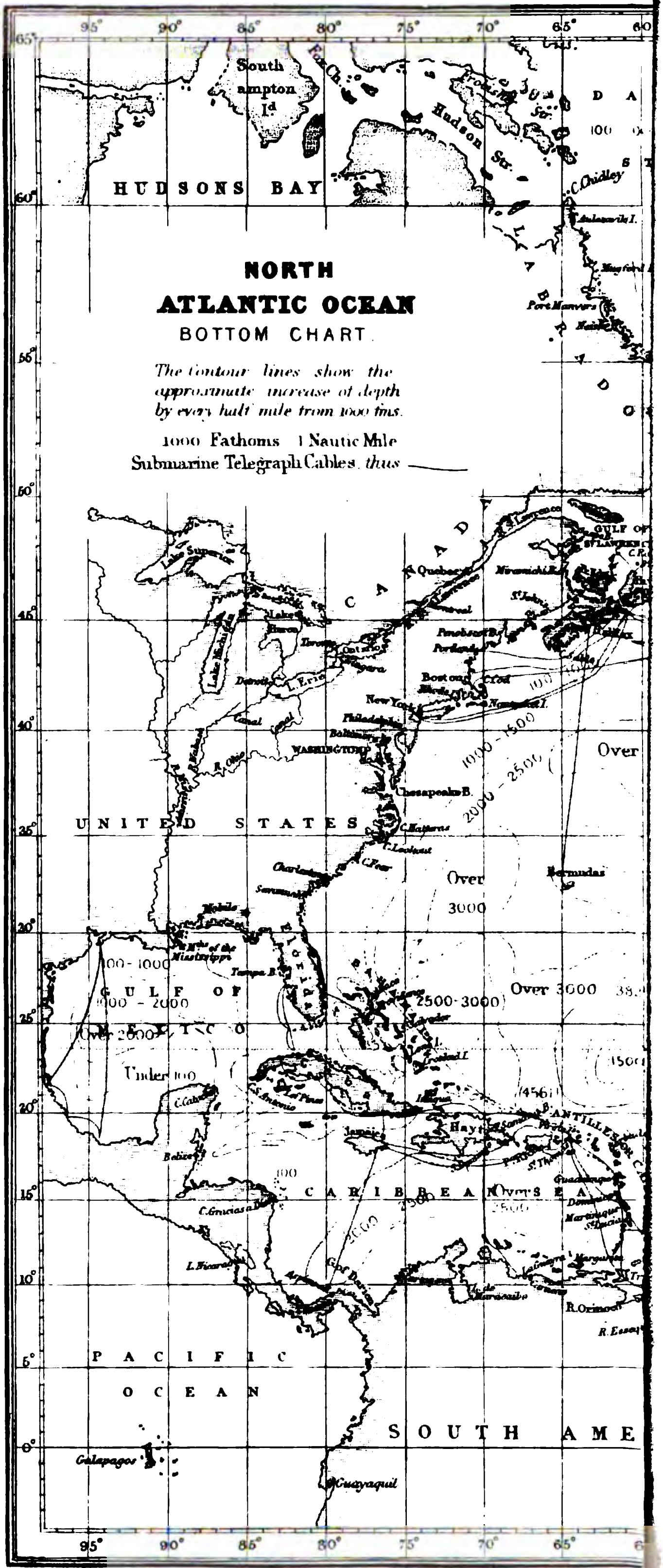

NORTH ATLANTIC OCEAN BOTTOM CHART

The contour lines show the approximate increase of depth by every half mile from 1000 fms.

1000 Fathoms 1 Nautic Mile

Submarine Telegraph Cables, *thus* ——

A. F. Findlay del.

A

DIRECTORY

FOR THE

NORTH ATLANTIC OCEAN,

COMPRISING

INSTRUCTIONS, GENERAL AND PARTICULAR,

FOR

ITS NAVIGATION.

BY ALEXANDER GEORGE FINDLAY, F.R.G.S.,

Honorary Member of the Societa Geografica Italiana.

FIFTEENTH EDITION.

REVISED AND EDITED BY W. R. KETTLE, F.R.G.S.

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1895.

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"O'ER the glad waters of the dark blue SEA,
Our thoughts as boundless, and our souls as free,
Far as the breeze can bear, the billows foam,
Survey our EMPIRE, and behold our HOME."
—*Lord Byron.*

ENTERED AT STATIONERS' HALL.

PRINTED BY RICHARD HOLMES LAURIE, 35, MINORIES, LONDON, E.

PREFACE

TO THE THIRTEENTH EDITION.

More than sixty years have elapsed since the First Edition of this work made its appearance—a period which has witnessed a total change in the aspect and requirements of Hydrography, as in most other departments of knowledge.

Professing to deal with the subject in its present condition, this Edition bears no resemblance to the book in its original form, except in the title it bears ; every topic and every page have been changed by the accession of facts, due to the research which modern refinement brings to bear upon every branch of scientific enquiry.

There has been no greater advance made during any portion of the long time which has elapsed, since its first appearance, than has taken place during the last twenty years ; and, to represent that advance, this Edition has been entirely remodelled, and may be considered rather as a new work upon the former arrangement, than as a revised production.

The examination of the bottom of the Ocean, almost a new subject, and yet in its infancy, has already dispelled many of those dangers which were formerly believed to exist. The various features which have been elucidated in the Wind and Current systems, and their bearings upon the best Routes for traversing the Ocean ; the more exact acquaintance with the Magnetical condition of the Earth, and the most important connection this has with the increasing number of iron ships ; with many other subjects, will be duly discussed in the ensuing pages.

To enumerate here the authorities to which we are indebted would be to offer a long list: we have duly acknowledged them throughout the work ; and we trust that this *Thirteenth Edition* may do as good service to the mariner in its quiet utility, as those which have preceded it.

A. G. Findlay.

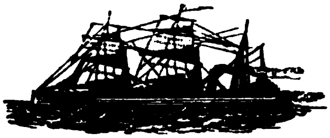
London, *February, 1873.*

The foregoing Preface may be said to apply equally to this *Fifteenth Edition,* in its reference to the rapid increase in our knowledge of the Ocean and its shores. In 1879 the *Fourteenth Edition* was issued, carefully revised, with numerous additions bringing it abreast of that date, and this has now in its turn been thoroughly revised. The Tables of Positions have been reconstructed; the Chapters and Diagrams on the Winds, Currents, and Passages, embrace information from the latest and most reliable sources of knowledge on these subjects, especially the Sections on the Winds and Weather of the Northern Atlantic, on the Gulf Stream, and on the new Uniform Routes for Steamers, to minimise the risks of collision; the subject of Ice, as a danger to navigation, is also fully discussed, and includes a Code of Ice Signals for the vicinity of the Newfoundland Banks; while the descriptions of the Coasts and Islands, and of the Scattered Rocks and Shoals, have been completely re-written. The theory of Storms and Hurricanes has received due attention, and the Section on Hurricanes and the Law of Storms, illustrated by new diagrams, has been entirely remodelled; as appertaining to the same subject, an article has also been added on the use of Oil in Calming Rough Seas, illustrated by diagrams. The latest information concerning the Depth, Temperature, &c., of the Ocean, has been collected and embodied in the Section on those subjects.

We could extend our remarks, but prefer that those who may use this Work should draw their own conclusions as to its value. We have now only to thank the numerous authorities, to whom we are indebted for the increase of our knowledge, which has added so considerably to the bulk of the volume, and to solicit fresh information from those who may be in a position to amend or add to it.

W. R. K.

LONDON, *October, 1894.*



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THE
NORTH ATLANTIC OCEAN.

INTRODUCTION.

THE NORTH ATLANTIC OCEAN is the smallest of all the great divisions of the Ocean, but it has ever been of far greater importance to man than all others collectively. It owes this maritime superiority to the great proportionate length of its varied coast-line, which perhaps nearly equals that of all other navigable seas, and to the vast area drained by the rivers falling into it, which give ready access to, and intercommunication between, seats of dense and inland population. It is from these causes that the inhabitants of its maritime countries have, in all ages, applied themselves to navigation; and it is more than probable that the facilities thus afforded by it for commerce and travel have caused the nations, who inhabit the vicinities of those vast inland seas and bays which distinguish the borders of the Atlantic, to make greater progress in civilization than those of any other part of the globe.

The area of the North Atlantic does not comprise more than about one-eleventh part of the entire ocean. From its having been the great highway for so many ages, its history, features, and phenomena are better known than those of any other, and we can now give a far more perfect view of it—in every aspect—than of the rest of the world of waters.

A committee appointed by the Royal Geographical Society defined:—

"The limits of the Arctic and Antarctic Oceans, respectively, to be the Arctic and Antarctic Circles; the limits of the Atlantic on the North and South, to be the Arctic and Antarctic Circles; its Western limit to be the coast of America, as far South as Cape Horn, and thence prolonged on the meridian of that Cape, until it meets the Antarctic Circle; its Eastern limit to be the shores of Europe and Africa, as far South as the Cape of Good Hope, and thence prolonged on the meridian of Cape Agulhas, till that meridian cuts the Antarctic Circle."

Our present work deals exclusively with the Northern portion of the area thus defined, or that part which is separated from the Southern by the Equator.

The length of the coast-lines which bound the North Atlantic and its chief bays (except the Mediterranean), measured around their principal sinuosities, is not less than 62,000 miles; if more minutely estimated, it would amount to much more. A Table is given presently, showing the figures which make up this sum. Of these coasts, about 7,000 miles, or one-ninth, remain unsurveyed; but they are the Arctic regions, unfrequented by commerce. Of the remainder, two-fifths have been surveyed by the English Government, and three-fifths by foreign powers. The whole of the coasts of the Atlantic Ocean are now represented on our charts with the most minute accuracy in nearly all places of interest to the sailor.

The first Chart of the Atlantic Ocean, upon a large scale, was published in Amsterdam by the renowned but now extinct house of Van Keulen, in the middle of the eighteenth century. It was issued under the title of the *Spanish* or *West Indian Sea,* and contained some useful details, amidst a thousand errors. The second, entitled a *Chart of the Atlantic Ocean,* was engraved at London, on the circular projection, invented by Mr. Murdoch, but was found to be extremely inaccurate, and the constructor added to the Cape Verdes, two islands, under the names of St. Philip and St. John, neither of which existed; these names being sometimes given by the Portuguese to the Islands Fogo and Brava.

The next, which was the first of the kind published in this country, was constructed by M. de la Rochette, a painstaking and talented hydrographer, in 1777; and was published by the house whence the present work issues, in that year. It was drawn upon the basis of the observations of M. Fleurieu, and for many years was in large demand; of which some degree of proof was given by its having been during that period repeatedly copied, and illegally published. In the course of time, many improvements were obtained, and it was superseded, in 1812, by another of the same scale and size, constructed by Mr. John Purdy, a name well known to mariners for many years. This chart, in its various editions, did good service to seamen for a long period.

These charts in their turn, requiring many improvements, from the great acquisition of exact knowledge during recent years, it was deemed necessary to supersede them by the charts which have been published by the proprietor of this work, as compiled from the now nearly perfect geographical data. They moreover exhibit, at one view, a summary, in a graphic form, of all that range of phenomena with which hydrography has of late been enriched.

But there is one drawback to the great increase of observation. Each department of hydrography is overloaded for practical every-day use, and the seaman would waste much time in endeavouring to elicit some system from the multifarious authorities he has now before him. A system of mean results has therefore been adopted, as will be hereafter explained, under the various sections which follow.

Hydrography, as at present understood, commenced with Captain Cook, in his celebrated first voyage to the South Seas, in 1768. Previous to this, our coasts were represented and corrected by the rude draughts and imperfect reckonings of painstaking mariners, in the pursuit of their profession; but the extended practice of lunars, and the use of chronometers, soon made great improvements in geographic representation. Captain Cook, prior to his appointment to the great Exploring Expedition, was employed in surveying portions of the Gulf of St. Lawrence; and the first work which he published was a series of charts of the South and West Coasts of Newfoundland. His charts, published by the predecessor of the proprietor of this work, have been till recently the only faithful representations extant.

Our present object is not to give a history of the progress of charts, or we might here present a long catalogue of those worthy observers, who, by patient investigation, and multiplied observation, made the geography of the ocean nearly as good, for the mariner's use, as the far more elaborate public surveys which have superseded them. These last have the exclusive merit of being connected, and each portion placed in exact relation to every other portion—a feature owing to the magnificent systems of triangulation, which are now extended over the most important portions of the civilized world.

It is the defect of detached observations that they do not exactly accord with those by different individuals. It was the discrepancies arising from this source, which necessitated the discussions formerly given on Atlantic geography. But still there is much that was useful in the older works, which is too often forgotten in the multiplicity of detail collected by modern surveyors, which overload as it were the subjects they embrace with too great a mass of knowledge for general use. Toward the end of the eighteenth century, there were several surveyors who deserve especial mention here, as their works, though carried out with very limited means and great personal labour, will bear every comparison with those of their more favoured successors. Among these was Murdoch Mackenzie, who surveyed a large portion of the Western shores of Scotland, and all the coasts of the North of Ireland. Græme Spence, an admirable surveyor, surveyed the Southern coasts of England, between 1772 and 1812.

The coasts of Spain and Portugal were laid down in accordance with the valuable surveys of Tofiño, Franzini, &c.; in the delineation of the African Coasts, with the islands off the same, the positions afforded by Messrs. Fleurieu, Verdun de la Crenne, Borda, Pingré, and Roussin of France, were the authorities for our charts.

The American Coasts were originally exhibited according to the observations and surveys of our illustrious countryman, Captain Cook, as before mentioned; those of Lieutenant Michael Lane, of Mr. Des Barres, of Captain Holland, of Messrs. Wright, Mason, Dixon, and De Mayne, rectified with the observations of Dr. Rittenhouse, Mr. Ellicott, Mr. Hassler, and other astronomers, &c., of the United States.

For the correct delineation of the West India Islands, much of our earlier information was derived from the labours of Messrs. Puysegur, Verdun, Borda, Pingré, and other foreign officers, whose names will be for ever entitled to respect. They were the pioneers who were followed by the skilful observers acting under the orders of the Hydrographic Directors of Madrid; particularly the Captains Joaquin Fr. Fidalgo, Cosme de Churruca, and Jose del Rio; to whom, and to the Baron von Humboldt, Messrs.

Oltmanns, &c., we were indebted for the proximate situations of many points of Spanish America. These have again been adjusted by English and United States Officers.

The more noted of the numerous surveyors who have seconded these scientific leaders in the completion of our hydrographic representations, will be alluded to in connection with their respective labours hereafter.

While we can refer with confidence to the charts of the various coast-lines, as being so perfect, that no possible alteration will be made in the fixed features of the land, which could be rendered applicable upon a general chart, there is one branch not so satisfactory, though much has been done to remedy this. This is the list of detached dangers, as rocks or shoals, which have been from time to time reported, and which, unless disproved, are a constant and daily source of great anxiety to those who have to pass their vicinity. To deal with the conflicting and ambiguous statements recorded, is most perplexing. Still it is most essential that no danger should remain unmarked, although its existence or situation may be involved in great doubt. It is of the utmost importance, therefore, to the facility and safety of navigation, that these dangers should be correctly placed and characterized, and in the case of a fresh discovery, some test, as by the sounding lead, ought to be applied, to determine its absolute existence. This is now most imperative; without such guarantee, any such announcement is next to worthless, as being authentic, and most mischievous, as leading to distrust and anxiety. All that we know of this subject is recorded in a later part of this work, and in the chart, but it may be stated that of late the extended practice of deep-sea soundings, has actually disproved the existence of many apparently well-authenticated dangers, and thrown very great doubt upon others.

Notwithstanding the great improvements made in recent times in the appliances placed at the disposal of the marine surveyor for the prosecution of his researches, perfection has not yet been obtained in the results. It is only necessary to refer here to such recent events as the stranding of H.M.S. *Sultan* in Comino Channel, Malta, on March 6th 1889, and of H.M.S. *Victoria*, at Dragomesti, on the coast of Greece, on January 29th, 1892, as examples of what defects in the work of the surveyors may lead to. In broad daylight and clear weather these fine vessels were both run aground on uncharted dangers, blind confidence having apparently been placed in the charts used in their navigation. From these, and similar cases mentioned hereafter, the moral may be deduced that no chart can be considered as *absolutely perfect*, and the mariner should exercise some amount of common sense in their use, especially when navigating in localities with which he is not familiar.

It has been before stated that the length of the coast-line of the North Atlantic Ocean, between the Arctic Circle and the Equator (excluding the Mediterranean), is about 62,000 miles, more or less. This estimate is higher than has been usually attributed, but it is the result of a measurement around the present surveyed coasts, omitting the minor sinuosities and smaller islets. If these were taken into the account the sum would be much greater, as may be supposed, upon an examination, for example, of the vast range of islets which front the coasts of Norway and Finland, but it is the length of line over which the patient marine surveyor has had to toil in the execution of his arduous but most important duties. These figures, however, but faintly express, as indeed anything we could say here would fall short of telling, how much has been done to bring the hydrography of this ocean to its present condition. It is enough here to draw the seaman's attention to a few of the results of those costly and laborious surveys by which he benefits.

Of the 62,834 miles of sea-coast, the English Government have surveyed about 23,600 miles, and foreign governments about 31,600 miles, the remainder being unsurveyed.

Of the coasts of Europe, the English Admiralty and Ordnance have only surveyed about 4,000 miles out of 19,000 miles.

The following Table of the details of the length of the coast, &c., of each country, is therefore given rather as a matter of curiosity than material utility, and will form a fitting introduction to the Geographic Tables which follow.

COUNTRY.	SURVEYED BY	DATE OF ORIGINAL SURVEY.	Extent of Coast Ge. miles	TOTAL GEO. MILES.
England; South Coast and Channel Islands	English Ordnance and Admiralty.	1792—1852	488	
East Coast........................	,,	1830—1859	470	
West Coast........................	,,	1772—1860	748	
Scotland; East and North Coasts, and Islands.........	,,	1815—1850	810	
West Coast and Islands......	,,	1750—1863	400	
Ireland	,,	1828—1858	1320	
Total British Isles	....	....	...	4236
Norway; West & South Coasts	Dan. & Norw. Gts.	....	2900	
Denmark; East Coast and Ids.	Danish Govt.	....	1585	
Prussia	Prus. & Dan. Govt.	....	625	
Russia and Finland..............	Russ. & Swed. Gt.	....	2720	
Sweden	Swedish Govt.	....	2360	
Total Baltic, &c.	....	....	...	10,190
Denmark; West Coast and Færöe Islands	Danish Govt.	1806—1841	...	730
Hanover.............................	Dutch Govt.	....	...	180
Holland	,,	....	...	540
Belgium.............................	French Govt.	1816—1839	...	64
France	,,	,, ,,	...	1687
Spain (to Gibraltar).............	Spanish Govt.	....	...	915
Portugal	Various.	....	...	540
Total Coasts of Western Europe	....	....	...	19,082
Morocco, &c.........................	Fr. and Eng. Gts.	1835—1858	460	
Agadir to Equator	English Govt.	1826	4430	
Total Africa	....	....	...	4890
Total Atlantic Islands	English Govt.	1783—1846	...	2990

COUNTRY.	SURVEYED BY	DATE OF ORIGINAL SURVEY.	Extent of Coast Ge. miles	TOTAL GEO. MILES.
Iceland	Danish Govt.	1845	1500	
Greenland	Not Surveyed	....	2000	
Hudson's Bay, &c.	"	....	4000	
Labrador; East Coast............	"	....	1140	
Total Arctic Lands, &c..........	....	....	...	**8640**
Newfoundland; East & South Coasts...........................	English Govt.	1765—1867	2765	
Gulf of St. Lawrence	"	1766, 1819, 1849	2820	
Cape Breton, Nova Scotia, and New Brunswick	"	1824—1860	1765	
Total British America	....	....	...	**7350**
United States; East Coast......	U.S. Government	1817——	3735	
South Coast	"	....	2770	
Total United States	....	....	...	**6505**
Mexico, and Central America...	Span. & Eng. Gts.	1808	3295	
Colombia and Guayana	Span. Fr. & Eng.	....	4100	
West India Islands (British)...	Various	....	2947	
Haiti and Cuba.....................	Not properly Sur.	....	2350	
Various Islands.....................	....	....	685	
Total West Indies, &c.	....	....	...	**13,377**

The following shows the general amount, the details of which are given above:—

COUNTRY.	TOTAL GEO. MILES.
EUROPE	19,082
AFRICA	4,890
ISLANDS	2,990
AMERICA	35,872
TOTAL LENGTH of the Coasts of the North Atlantic Ocean	**62,834**

SECTION I.

TABLES OF DETERMINED POSITIONS, THE AUTHORITIES, THE VARIATION OF THE COMPASS, ETC.

The first portion of this volume consists of a selection of the principal geographical points established in the surveying operations, and appended to them are some notes, which will sufficiently explain their nature. In former editions we were led to discuss more fully the merits of the various authorities and the discrepancies between them, which were often considerable in amount. Owing chiefly to the extension of the telegraphic system, these differences have been so overcome, and such minute exactness attained, that whatever notes are still retained on this topic, must be taken rather as subjects of curiosity than of practical utility. The names of the original observers are also retained in many places in the Tables, more as a record of their services, than as authorities for the positions now given, as may be gathered from the above remarks.

It is manifestly impossible that the seaman in the ordinary pursuit of his calling can hope to improve what has cost so much labour, with such refined appliances. The *Secondary Meridians*, and many other points in the Geographic Tables which follow, may be taken as points of departure by which he may correct his reckoning and rate his chronometer; and the explanatory notes appended will serve to give him confidence, and afford information upon this important section of hydrography.

Where telegraphic communication renders it possible, the true longitude of a station may be very accurately ascertained by comparing by signal two chronometers, whose errors are known, one at each end of the line. Differences of longitude may thus be measured, step by step, from the prime meridian. Since 1873, the United States Hydrographic Office has determined by this method the positions of the chief points of the New World, including the West Indies, and some of the results are given in the following Tables.

Secondary Meridians are printed in larger characters, thus: PORTSMOUTH, BRUSSELS, PARIS.

1. ENGLAND AND WALES.

*** *The* FIGURES *in Brackets refer to the* NOTES *subjoined to each Section.*

	LAT. N.	LONG.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
GREENWICH, ROYAL OBSERVATORY ....[1]	51 28 38	0 0 0	16 30	The Astronomers Royal.
		Long. W.		
London, Cupola of St. Paul's Cathedral	51 30 49	0 5 48		The GRAND TRIGONOMETRICAL or ORDNANCE SURVEY, one of the great works of which our country ought to feel proud, was commenced in 1783, with a view to ascertain the difference of longitude between the Observatories of Paris and Greenwich, under General Roy. The principal triangulation was gradually extended under the successive directions of Colonel Williams, General Mudge, Gen. Colby, Colonel Hall, and Colonel Sir Henry James. It was completed and the account of it published in 1858. The bases upon which it is constructed were measured on Salisbury Plain, and upon the shore of Lough Foyle, Ireland, that at the former being 36,577·8581 feet, or a little under 7 miles, and that at Lough Foyle being 41,640·8873 feet, or a little under 8 miles. The refinement attained may be judged of when it is stated, that the difference between the calculated and measured lengths of these bases was less than 2¼ inches. The mean length of the sides of the great triangles is 35·4 miles, of which 11 exceed 100 miles in length; the longest is 111 miles, *i.e.* from Slieve Donard in Ireland, county Down, to Sca Fell, Cumberland.
KEW OBSERVATORY	51 28 6	0 18 46		
		Long. E.		
Tilbury Fort, Flagstaff ...	51 27 7	0 22 42		
Gravesend, Church	51 26 39	0 22 10	16 20	
Sheerness, Flagstaff.........	51 26 47	0 44 50		
Harwich, old Lighthouse...	51 56 38	1 17 25		
Orfordness, Lighthouse ...	52 5 0	1 34 34	15 50	
Lowestoft, Lighthouse......	52 29 12	1 45 28		
Haisbro' Upper Lighthouse	52 49 12	1 32 20		
Cromer, Lighthouse.........	52 55 27	1 19 6		
Spurn High Lighthouse ...	53 34 41	0 7 11		
		Long. W.		
Flamborough Lighthouse .	54 6 58	0 4 51	17 10	
Hartlepool Heugh Light...	54 41 47	1 10 27		
Sunderland, North Pier Lighthouse..................	54 55 5	1 21 30	18 0	
Souter Point, Lighthouse	54 58 15	1 21 30		
Tynemouth Lighthouse ...	55 1 5	1 24 52		
North Shields, Lighthouse	55 0 31	1 26 10		
Blyth, High Lighthouse ...	55 7 33	1 29 50		
Coquet Island Lighthouse	55 20 2	1 32 17		
Farn Island, S.W. Lt.-ho.	55 36 55	1 39 15		
Berwick, Lighthouse	55 45 58	1 58 57		
		Long. E.		
North Foreland, Lightho.	51 22 28	1 26 48	15 50	
Deal, Time Ball...............	51 13 20	1 24 20		
South Foreland, High Lighthouse..................	51 8 23	1 22 22		
Dover Castle, the Keep ...	51 7 46	1 19 23		
Folkestone, Lighthouse ...	51 4 41	1 11 33		
New Romney Church	50 59 0	0 56 40		
Lydd Church..................	50 57 5	0 54 29		
Dungeness, Lighthouse ...	50 54 47	0 58 18	16 0	
Bexhill Church	50 50 45	0 28 48		
Beachy Head, Lighthouse	50 44 15	0 12 58	16 15	
Newhaven, Breakwater Lighthouse..................	50 46 35	0 3 30		
		Long. W.		
Brighton Church	50 49 32	0 7 40		
Shoreham Church	50 50 0	0 16 19		
Selsea Church	50 45 19	0 45 55		
Chichester Spire	50 50 0	0 46 43		

ENGLAND, SOUTH COAST.

3

	LAT. N. ° ′ ″	LONG. W. ° ′ ″	VAR. WEST, 1895. ° ′
Portsmouth, Observatory	50 48 3	1 5 53	16 50
Southsea Castle	50 46 39	1 5 10	
Calshot Castle	50 49 9	1 18 22	
Southampton, Observatory	50 54 49	1 24 6	
Southampton, West Pier	50 53 42	1 24 23	
Hurst Castle, East Light	50 42 27	1 32 56	
Dunnose, Station in the Survey	50 37 6	1 11 50	
St. Catherine's Lighthouse, Isle of Wight	50 34 30	1 17 47	17 0
Needles Lighthouse	50 39 40	1 35 25	17 10
Christchurch Head	50 42 38	1 44 45	
Anvil Point, Lighthouse	50 35 30	1 57 30	
Poole Church	50 42 46	1 59 18	
Portland, Upper Lightho.	50 31 17	2 27 18	17 35
Lyme Cobb	50 43 11	2 56 0	
Hob's or Hope Nose	50 27 40	3 28 43	
Berry Head, Flagstaff	50 23 55	3 28 50	
Dartmouth Harbour, St. Petrox Church	50 20 29	3 33 54	
Start Point, Lighthouse	50 13 18	3 38 28	18 0
Bolt Head, Signal Station	50 13 5	3 48 40	
Eddystone Lighthouse	50 10 49	4 15 53	
Mewstone, near Plymouth Sound	50 18 20	4 6 20	
Plymouth, Smeaton's Tower on the Hoe	50 21 50	4 9 30	
Drake's Island, East end	50 21 15	4 9 5	
Lighthouse, on the West end of Breakwater	50 20 2	4 9 27	18 20
Meridian Tablet, on the Breakwater [2]	50 19 59	4 8 52	
Penlee Beacon	50 19 20	4 11 35	
Rame Head, Flagstaff	50 18 58	4 13 25	
Dodman or Deadman Point, Flagstaff	50 13 20	4 48 1	18 40
St. Anthony's Head, Lighthouse [3]	50 8 25	5 0 50	
Pendennis Castle, Flagstaff	50 8 44	5 2 45	
St. Kevern Steeple	50 3 7	5 5 8	
Blackhead, Flagstaff	50 0 20	5 6 15	
Lizard, East Lighthouse	49 57 35	5 12 5	18 40
St. Michael's Mount, Tower	50 6 55	5 28 37	
St. Paul's Steeple, Mount's Bay	50 5 20	5 32 48	
St. Leven's, or Guethensbras Point, Flagstaff	50 2 10	5 40 46	
Wolf Rock, Lighthouse	49 56 43	5 48 27	
Land's End House	50 3 50	5 42 50	19 0
Longships Lighthouse	50 3 57	5 44 45	
Scilly Islands, St. Agnes' Lighthouse	49 53 31	6 20 41	19 15
St. Mary's Flagstaff, at the Fort	49 54 50	6 19 15	

AUTHORITIES.

The Grand Trigonometrical or Ordnance Survey of England, &c.

Remarks.

As a matter of curiosity it may be mentioned that, by elaborate computations, the Equatorial radius of the earth is found to be 20,926,500 feet; the Polar radius 20,855,400 feet; and a mean degree of the meridian contains 364,616 feet. The ellipticity of the earth is as 294 is to 295, and the mean density is 5·316.

These geodetic operations have now been carried to such a degree of refinement, that the varied density of the strata in different regions has a marked effect on their results. It has been argued by Archdeacon Pratt (of Calcutta) that this is sufficient to cause a deflection of from 20″ to 30″ in the perpendicularity of the plumb-line; and this of course affects, in a corresponding degree, the determinations of the exact latitude, and with that the true figure of the earth.

ENGLAND AND WALES.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
Scilly Islands—*continued.*	°	′	″	°	′	″	°	′	
St. Martin's Daymark	49	57	50	6	15	58			The GRAND TRIGONOMETRICAL or ORDNANCE SURVEY of England, &c.
Bishop Rock Lighthouse	49	52	20	6	26	39			
Round Island Lightho.	49	58	40	6	19	20			
Godrevy Island, Lightho.	50	14	32	5	23	56			
St. Agnes' Beacon, Cornwall	50	18	24	5	12	56	18	50	
Trevose Head, Lighthouse	50	32	55	5	2	3			
Hartland Point, Lightho.	51	1	24	4	31	52			
Lundy Island, Lighthouse	51	10	0	4	40	20	18	50	
Braunton Sands, Lower Lighthouse	51	4	17	4	12	19	18	35	
Minehead Steeple	51	12	36	3	28	48			
Burnham (or Bridgewater) Lighthouse	51	14	54	2	59	52			
Bridgewater Spire	51	7	41	3	0	10			
Avon Lighthouse	51	30	2	2	42	0			
Bristol Cathedral	51	26	48	2	35	29	17	50	
Usk Lighthouse	51	32	24	2	59	33	18	5	
Cardiff, East Lighthouse	51	27	46	3	9	45			
Flatholm, Lighthouse	51	22	31	3	7	3			
Nash Point, E. Lighthouse	51	24	2	3	33	19			
Swansea Castle	51	37	25	3	56	25			
Mumbles Lighthouse	51	33	59	3	58	12	19	0	
Worms Head	51	33	55	4	19	54			
Pembrea Steeple	51	41	5	4	16	25			
Tenby Spire	51	40	15	4	41	45			
Caldy Island, Lighthouse	51	37	52	4	40	59			
Milford Steeple	51	42	43	5	1	45	19	15	
St. Anne's High Lighthouse	51	40	55	5	10	28			
Grassholm Islet	51	43	50	5	28	45			
Smalls Lighthouse	51	43	14	5	40	8	19	35	
St. David's Cathedral	51	52	56	5	16	0			
Ramsay Island, highest point	51	51	43	5	20	44			
Bishop and Clerks Rocks, northernmost	51	54	10	5	23	6			
Cardigan Isle, highest point	52	7	54	4	41	26			
Cardigan Steeple	52	4	59	4	39	17			
Aberystwith, Castle Church	52	24	50	4	5	20	18	55	
Cardigan Bay Lightvessel	52	24	30	5	0	30	19	30	
Bardsey Lighthouse	52	44	58	4	47	55			
St. Tudwall Lighthouse	52	47	54	4	28	13			
Caernarvon Bay Lt.-vessel	53	5	40	4	44	30	19	30	
South Stack Lighthouse	53	18	23	4	41	55			
Holyhead, Lighthouse	53	18	50	4	37	7	19	30	
Skerries Light	53	25	15	4	36	26			
The West Mouse	53	25	0	4	33	10			
Lynus Point, Lighthouse	53	25	0	4	17	10			
Great Ormes Head, Lighthouse	53	20	35	3	51	55	19	10	
Abergelé Steeple	53	17	8	3	34	57			
Air Point, Lighthouse	53	21	24	3	19	15			
Leasowe Lighthouse	53	24	46	3	7	28			
BIDSTON OBSERVATORY	53	24	4	3	4	18			

ENGLAND, WEST COAST.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Black Rock, Lighthouse...	53 26 39	3 2 28		The GRAND TRIGONOMETRICAL or ORDNANCE SURVEY of England, &c.
Liverpool, Custom House	53 24 10	2 59 12	18 40	
North-West Lightship......	53 30 52	3 30 48		
Formby Lighthouse.........	53 32 19	3 3 56		
Formby N.W. Mark	53 34 0	3 5 58		
Rossal Point, Landmark...	53 55 15	3 2 56		
Fleetwood, Lighthouse ...	53 55 35	3 0 22		
Wyre Lighthouse............	53 57 18	3 1 46		
Lancaster Steeple............	54 3 4	2 48 14		
Walney Island, Light	54 2 55	3 10 33	19 0	
St. Bees Head, Lighthouse	54 30 48	3 38 8	19 20	
Whitehaven, Pier-head Lt.-house	54 33 10	3 35 50		
Maryport, Lighthouse......	54 43 0	3 30 21		
Lee Scar Lighthouse	54 51 46	3 24 43		
Skinburness Lighthouse ...	54 52 47	3 22 46		
Workington, Chapel Hill...	54 38 28	3 34 11		
Southerness, Lighthouse...	54 52 22	3 35 37	19 25	
Criffell, Station in the Survey, 1,831 feet above sea	54 56 26	3 37 37		
ISLE OF MAN.				
Point of Ayre, Lightho.	54 24 56	4 22 1	19 45	
North Barrule, Station, 1,840 feet high	54 17 27	4 28 32		
Snea Fell, Stat., 2,034 ft.	54 15 50	4 27 35		
Chicken Rock, Lightho.	54 2 15	4 50 10	19 50	
Peel, Lighthouse	54 12 45	4 42 33		

NOTES.

1. **GREENWICH OBSERVATORY**, the *Prime Meridian*.—This Observatory was founded during the reign of Charles II., and the Prime Meridian in general use passes through its great transit instrument. In 1884, a Conference of delegates, appointed by twenty-five European and American countries, assembled at Washington, in the United States, for the purpose of fixing a universal Prime Meridian, to do away with the inconvenience experienced from various countries each assuming a meridian of its own. Twenty-two delegates voted in favour of Greenwich; San Domingo voted in the negative; while Brasil and France abstained from voting, the latter favouring a so-called "neutral" meridian, to pass through the Azores or Behring Strait. The Geodetic Conference held at Rome, in 1883, also very decisively expressed its opinion in favour of Greenwich.

French charts adopt the meridian of Paris; Spain adopts the meridian of San Fernando, Cadiz; and Portugal that of Lisbon. Most other nations use the meridian of Greenwich.

From 720 observations of the Pole Star, made during eighteen months of 1825 and 1826, the latitude of the Royal Observatory was deduced as 51° 28′ 38″. By a later correction it was placed in 51° 28′ 40·16″; but by the Grand Trigonometrical Survey it is taken as 51° 28′ 38·30″.

2. **PLYMOUTH BREAKWATER.**—On the northern side, near the centre, is a landing pier, on the East end of which is a granite pillar, with a brass plate, on which is engraved its correct latitude and longitude, 50° 19′ 59″ N., 4° 8′ 52″ W.

8. **Falmouth.**—Dr. Tiarks ascertained, in the summer of 1822, by the comparison of sixteen excellent chronometers, carried backward and forward between Greenwich and Falmouth, that the western longitude of the latter had been given at 4·4 seconds of time, or 1′ 6″ of arc too little, by the first Trigonometric Survey. In consequence, twenty-nine of the best chronometers belonging to the Admiralty were subsequently committed to the care of the doctor, and a vessel was appointed wherein he was to sail, backward and forward, between Dover and Falmouth, until the longitude in time, between these stations, and between them and Portsmouth, as an intermediate station, was settled beyond any doubt. The result was, as to all places on the South Coast of England, between the meridians of Greenwich and Falmouth, if 1 second be added to every 4 minutes of longitude, as given by the original Survey, the exact longitude, according to the chronometers, will be obtained. These differences have since been entirely settled by the re-examination of the triangles, now completed.

VARIATION OF THE COMPASS.

In the latter part of this volume, some observations on the general subject will be found, among which, as to the secular change, which requires attention, the more especially from the care demanded in the navigation of iron ships. In these Tables we give the *approximate* variation for the year 1895, reserving such remarks upon former results for the section specially devoted to the subject.

The Variation is now *decreasing* on the Coast of England at an average rate of about 5½′ or 6′ per annum, according to the most recent observations at the Greenwich Observatory, varying irregularly from 5′ to 8½′ between successive years. The rate at which it is increasing or decreasing in this and other regions is also shown on the special Diagram given hereafter.

2. ISLANDS AND COASTS OF SCOTLAND.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Edinburgh; the Observatory .... [1]	55 57 23	3 10 54	19 30	The **Grand Trigonometrical** or **Ordnance Survey** of Great Britain.
Inchkeith Lighthouse	56 2 1	3 8 5		
Isle of May, Lighthouse ...	56 11 9	2 33 22		
East Lomond, 1,461 ft. ...	56 14 31	3 13 10		
Fifeness	56 16 45	2 35 0		
Bell Rock, Lighthouse......	56 26 4	2 23 7	19 5	
Dundee Law	56 28 11	2 59 10	19 25	
Buddon-ness, High Light	56 28 8	2 44 54		
Arbroath, the Abbey	56 33 45	2 34 58		
Red Head	56 36 55	2 29 24		
Montrose, Scurdy Ness, Lighthouse........	56 42 5	2 26 6		
Girdleness, Lighthouse ...	57 8 15	2 2 40		
Aberdeen, Marischal Coll.	57 8 57	2 5 42	19 5	
Aberdeen, North Breakwater Lighthouse.........	57 8 33	2 4 6		
Belhelvie or Orrock, Dovecote........	57 15 52	2 8 57		
Buchanness, Lighthouse...	57 28 14	1 46 22		
Peterhead, Old Mill.........	57 30 44	1 47 32		

ISLANDS AND COASTS OF SCOTLAND.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Rattray Head, Pile	57	36	52	1	50	39			The Grand Trigonometrical or Ordnance Survey.
Fraserburgh, Kinnaird Head Lighthouse	57	41	52	2	0	6	19	10	
Troup Head, Staff	57	41	38	2	17	38			
Macduff, Spire	57	40	5	2	30	0			
Covesea Skerries, Lightho.	57	43	15	3	20	20			
Tarbetness, Lighthouse ...	57	51	55	3	46	31	20	20	
Noss Head, Lighthouse ...	58	28	38	3	3	30			
Duncansby Head	58	38	30	3	1	30	20	5	
Dunnet Head, Lighthouse	58	40	19	3	22	29			
ORKNEY—Pentland Skerries, Upper Light... [2]	58	41	26	2	55	28	20	0	
Stromness, Church	58	57	44	3	17	57			
Hoy, Rora Head	58	52	30	3	26	0			
Cantick Head, Lightho.	58	47	10	3	7	50			
Kirkwall Light	58	59	9	2	57	28			
Start Point of Sanda, Lighthouse...............	59	16	42	2	22	30			
N. Ronaldshay, Lightho.	59	23	5	2	22	10	19	45	
Stronsay, Station in Survey	59	5	38	2	32	34			
Fair Island, summit.........	59	32	45	1	37	50			
Scaddon Lighthouse......	59	30	45	1	39	0			
Foul Island, sum. (1,369 ft.)	60	8	24	2	5	38	19	50	
Sule Skerry	59	4	50	4	24	0			
North Rona Island	59	7	16	5	48	47			
SHETLAND— Sumburgh Head, Lighthouse......	59	51	17	1	16	28	19	0	The Observations of Mr. George Thomas, R.N., on his Survey of Shetland, &c., 1825 to 1833, and later observers.
Bressay Island, summit	60	7	48	1	5	41			
Lerwick; the Fort Flagstaff........................	60	9	22	1	8	35			
Whalsey Island, summit	60	20	1	1	0	22			
Out Skerries, Lighthouse	60	25	30	0	44	0			
Yell Isle, Reafirth Kirk	60	35	55	1	3	46			
Fetlar Isle, summit	60	37	12	0	51	50			
Haaf Gruna, summit ...	60	39	44	0	50	24			
Balta Island, summit ...	60	45	3	0	47	17	18	55	
Saxavord, Stat. in Survey	60	49	39	0	50	20			
Lambness, on Unst	60	49	0	0	45	40			
Burraford Holmes, Lt.-house	60	51	20	0	53	0			
Ramna Stacks, N. end...	60	39	50	1	18	30			
Ve Skerries, off St. Magnus Bay	60	22	30	1	48	45			
Fugloe Skerry, near Papa	60	20	15	1	45	0			
Scalloway Castle	60	8	10	1	16	19			
Western Coasts.									
Holburn Head	58	37	20	3	32	15	20	25	
Cape Wrath, Lightho. [3]	58	37	33	4	59	52	21	30	
Loch Laxford, N.W. Point	58	24	40	5	8	20			

ISLANDS AND COASTS OF SCOTLAND.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Ru Stoer, Lighthouse	58 14 15	5 23 50		The ADMIRALTY SURVEY, based on the Ordnance Triangulation.
Flannan or Seven Hunters, Eilean Mor..................	58 17 15	7 35 20	23 15	
Butt of Lewis, Lighthouse	58 30 50	6 15 40	22 20	
Ru Rea, Station in Survey	57 50 8	5 45 53		
Stornoway Lighthouse, in Lewis	58 11 30	6 22 10		
Glash or Scalpa, Lightho.	57 51 23	6 38 28	22 25	
Storr Hill, in Skye	57 30 25	6 10 52		
St. Kilda, Peak at N.E. end	57 49 2	8 34 30	23 40	
Monach Isles, Shillay Lt.-house	57 31 34	7 41 39		
Ben More, S. Uist; Station	57 15 31	7 17 35		
Barra Head, Lighthouse...	56 47 8	7 39 9	22 45	
Skerryvore Lighthouse ...	56 19 24	7 6 45	22 5	
Dubh Artach Lighthouse...	56 8 0	6 38 0		
Ardnamurchan Pt., Lt.-ho.	56 43 45	6 13 30	21 40	
Tobermory, Mull; Light on Runa Gal Rock	56 38 20	6 4 0		
Lismore Lighthouse, Sound of Mull	56 27 21	5 36 28	21 5	
Oban, Light on Pier.........	56 24 50	5 28 20		
Ben Nevis, summit	56 47 50	5 0 30		
Ben Tartevil, or Tart-a-bhaile, Islay Island	55 48 32	6 26 33		
Rhynns of Islay, Lightho.	55 40 28	6 30 44	21 30	
Jura Island, North Pap, 2,659 feet	55 54 8	6 0 9		
Sgeir Maoile Lighthouse...	55 52 27	5 49 47		
Mull of Cantyre, Lightho.	55 18 33	5 48 8	20 50	
Sanda Island, Ship Rock Light	55 16 30	5 34 55		
Campbelltown, Devaar Lt.	55 25 45	5 32 16		
Goat Fell, Arran Island ...	55 37 33	5 11 24		
Ben Lomond, Station in Survey	56 11 25	4 37 52		
Troon, Lighthouse	55 34 33	4 41 39	20 15	
Pladda Lightho., Arran Id.	55 25 31	5 7 2		
Little Cumbrae, New Lighthouse	55 43 16	4 57 57		
Toward Point, Lighthouse	55 51 44	4 58 43		
GLASGOW OBSERVATORY ...	55 52 43	4 17 39	20 0	
Ardrossan, Horse Island Mark	55 38 40	4 50 28		
Ayr, Lighthouse	55 28 9	4 38 11		
Turnberry Point, Lightho.	55 19 30	4 50 20		
Corsewall Point, Lightho.	55 0 25	5 9 30	20 20	
Mull of Galloway, Lightho.	54 38 6	4 51 22	20 5	
Southerness, Lighthouse...	55 52 22	3 35 37		

NOTES.

1. Edinburgh.—The geographic position of the Astronomical Observatory on the Calton Hill, was given by the Ordnance Survey, in 1816, as longitude 3° 10′ 54″ W. But this result appears to have been affected by a singular cause, which demonstrates the refinement to which these operations have been carried. It was afterwards found that the attraction of the mass of Arthur's Seat (a hill to the southward of it) had drawn the plumb-line (or zenith sector) towards it, and thus produced an error of several seconds in the calculation. This error was established in 1839, by Professor Henderson, who made the longitude 3° 10′ 45″. Some interesting experiments were made on this curious point, during the late Ordnance Survey, by which, not only the effect of mountainous masses on surveying operations was ascertained, but also the density of the earth was established.

Since the completion of the triangulation of the Ordnance Survey, a new principle for ascertaining the difference of longitude has come into operation. The extension of the electric telegraph has placed Greenwich Observatory in direct connection with most other important Observatories; and in April, 1857, a series of instantaneous signals was transmitted between it and Edinburgh, under the direction, at the latter place, of Professor Piazzi Smyth, the worthy son of the excellent Admiral Smyth, well known to all sailors. The results of these experiments placed its longitude at $12^m\ 43{\cdot}048^s$ in time, or 3° 10′ 45·72″ in arc, confirming Mr. Henderson's previous result. It is now, however, considered to be in long. 3° 10′ 54″.

2. Orkneys, &c.—The Orkney Islands were originally surveyed by the elder Mackenzie. Murdoch Mackenzie, F.R.S., was the first surveyor of our coasts, who conducted his operations on right principles. His first work, *Orcadia, or the Orkney Islands, with part of Lewis*, was done at his own expense, and was published in 1750. Its accuracy is great, and its utility is still unequalled. He was afterwards employed by the king in surveying the coasts of Ireland, &c. Later in life his works were attacked, most unjustly, by Dr. Anderson, which called forth suitable replies and justification from John Clark, in 1785. This work may be said to have commenced the Admiralty Surveys.

3. West of Scotland, and the Hebrides.—Up to a recent date the charts of the whole of this portion of our shores remained nearly in the same state that they were left by Murdoch Mackenzie. Notwithstanding their imperfections, however, statistics have shown that no great detriment to navigation arose from their so-called "disgraceful" condition, an epithet which took twenty-five years of organized surveying parties, and £250,000, to remove.

We may here add that they were examined, and partially surveyed, by Captain Joseph Huddart, whose charts were long of good service. Captain Huddart also surveyed a great portion of the St. George's Channel at the expense of the predecessors of the publisher of this work.

The Variation of the Compass on the Coasts of Scotland is now *decreasing* at the rate of about 9′ per annum.

3. COASTS OF IRELAND.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
The Northern Coast.									
Tory Island, Lighthouse...	55	16	20	8	15	0	22	35	The **Grand Trigonometrical Survey** of Ireland, and the Surveys of Capt. William Mudge, R.N., F.R.A.S., and other Officers.
Fannet Point, Lighthouse	55	16	34	7	37	52			
Innistrahul, Lighthouse ...	55	25	57	7	13	37	21	55	
Lough Foyle, Dunagree Point, E. Lighthouse	55	13	38	6	55	38			
Magilligan Tower ...[1]	55	11	32	6	57	58	21	35	
Londonderry Cathedral	54	59	40	7	19	25			
Port Rush	55	12	30	6	39	30	21	25	
Bengore Head	55	15	10	6	28	15			
Rathlin Isle, Lighthouse...	55	18	10	6	10	15			
Knocklaid Mountain (1,690 feet)...........................	55	9	43	6	14	57			
Fair Head	55	13	30	6	9	0	21	0	
The Eastern Coast.									
Tor Point	55	11	50	6	3	40	20	55	
Garron Point..................	55	3	0	5	57	50			
The Maidens, West Rock Lighthouse..................	54	55	47	5	44	18	20	40	
Hunter Rock (9 feet)	54	52	55	5	45	10			
Black Head	54	46	0	5	41	20			
Carrickfergus Castle.........	54	42	50	5	48	15			
Belfast, Mouth of the Lagan.....................	54	36	0	5	55	10	20	40	
Divis Mount (1,560 ft.)	54	36	40	6	1	10			
Bangor Castle	54	39	20	5	40	10			
Copeland Lighthouse	54	41	45	5	31	21			
Donaghadee, Pier Head ...	54	38	38	5	31	50			
Ballyhalbert, Fort	54	29	30	5	27	10			
South Rock, Old Lightho.	54	23	56	5	25	4	20	20	
St. John's Point, Lightho.	54	13	34	5	39	30			
Slieve Donard (2,797 ft.)...	54	10	49	5	55	10			
Carlingford, Haulbowline Rock Lighthouse	54	1	11	6	4	41	20	35	
Hill (1,920 ft.)	54	2	39	6	13	0			
Clogher Head	53	47	45	6	13	0			
Drogheda, Bridge............	53	42	50	6	20	58			
Balbriggan, Light............	53	36	46	6	10	38			
St. Patrick's Island	53	35	5	6	4	25			
Rockabill Lighthouse	53	35	45	6	0	25	20	25	
Lambay Island, summit...	53	29	30	6	1	0			
Howth Hill, peak (548 ft.)	53	22	28	6	4	8			
Howth Bailey, S.E. point, Lighthouse..................	53	21	41	6	3	5			
Poolbeg Lighthouse.........	53	20	31	6	9	1			
Dublin, Nelson's Pillar [2]	53	21	0	6	15	15	20	30	
Dunsink Observatory	53	23	13	6	20	30			
Kingstown, Lighthouse on East pier	53	18	7	6	7	31			
Wicklow Head, Upper Lt.	52	57	54	6	0	5			

COASTS OF IRELAND.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Tara Hill	52	41	56	6	12	58			The Grand Trigonometrical Survey, &c.
Forth Mountain	52	18	58	6	33	39			
Rosslare Harbour, Pier Lt.	52	15	10	6	20	0			
Tuskar Lighthouse	52	12	9	6	12	22	20	0	
The Southern Coast.									
Saltees Lightvessel	52	2	18	6	39	30			
Coningmore Rock	52	5	10	6	37	30			
Hook Lighthouse, near Waterford	52	7	24	6	55	48	20	25	
Helwick Head	52	3	10	7	32	15			
Mount Knockmeldown	52	13	40	7	54	51			
Roche Point, Lighthouse	51	47	33	8	15	15			
Daunt's Rock Lightvessel	51	43	0	8	16	0			
Roberts Head	51	43	55	8	18	50			
Kinsale, South Lighthouse	51	36	11	8	31	58	21	10	
Galley Head, Lighthouse	51	31	50	8	57	10			
Stags of Castlehaven	51	28	0	9	13	30			
Cape Clear, Old Lighthouse	51	26	2	9	29	3	21	45	
Fastnet Rock, Lighthouse	51	23	18	9	36	25			
Crookhaven, Lighthouse	51	28	35	9	42	39			
Mizen Head	51	27	0	9	49	30			
Mount Gabriel	51	33	30	9	32	30			
Sheep Head	51	32	30	9	51	15			
Hungry Hill, Station in Survey	51	41	18	9	47	27			
Bantry Bay, Roancarrig Island, Lighthouse	51	39	10	9	44	49			
Bear Island, Signal Tower on West end	51	37	48	9	53	40	22	5	
The Western Coast.									
Dursey Island, South Point	51	34	45	10	14	10			
Bull Rock, Lighthouse	51	35	30	10	18	8	22	20	
Skelligs, Lighthouse	51	46	6	10	32	29			
Valentia Isle, Cromwell Point Fort	51	55	50	10	19	15	22	30	
Feaghmaan Station at West end [3]	51	55	22	10	20	41			
Doulus Head	51	57	6	10	19	20			
Dunmore Head, Dingle Bay	52	6	30	10	28	40			
Tearaght Island, Lightho.	52	4	30	10	40	0	22	50	
Great Foze Rock	52	1	15	10	41	5			
Mount Brandon, Station	52	14	6	10	15	10			
Kilcradan Head, Lightho.	52	34	47	9	42	34			
Scattery Id., Round Tower	52	36	42	9	31	15			
Limerick Cathedral	52	40	4	5	37	28	21	40	
Loop Head, Lighthouse	52	33	38	9	55	55	22	30	
Mutton Island, Lighthouse	53	15	14	9	3	11			
Arran Island, Lighthouse	53	7	38	9	42	6			
Slyne Head, N. Lighthouse	53	23	59	10	14	1	23	5	
Inishgort Lighthouse	53	49	35	9	40	13			

WEST COAST OF IRELAND.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Clare Island, Lighthouse...	53 49 38	9 58 53		The GRAND TRIGONOMETRICAL SURVEY, &c.
Achil Head	53 58 20	10 16 0	23 20	
Slieve More, Achil Island	54 0 35	10 3 26		
Eagle Island, Lighthouse...	54 16 0	10 5 32		
Tawnaghmore, Station ...	54 17 40	9 35 47		
Telling or Teelin Head ...	54 42 0	8 48 10		
Rathlin O'Birne Lightho.	54 39 47	8 49 52	22 40	
St. John's Point, Lightho.	54 34 8	8 27 33		
Ballyshannon Church... ...	54 30 11	8 11 47		
Slieve League (1,977 feet)	54 39 5	8 42 19		
Rinrawros Point, Lightho.	54 50 0	8 33 30		
Bloody Foreland (1,024 ft.)	55 8 14	8 15 41	22 30	
Muckish Hill (2,186 ft.) ...	55 6 0	7 59 49		
Rockall	57 36 20	13 41 32	27 20	Capt. Vidal, &c.

NOTES.

1. The positions of places on the Irish coasts depend upon the observations made in the Trigonometrical or Ordnance Survey. The principal triangles, commencing with the measurement of the base on the East side of Lough Foyle, in 1826-8, were extended over the whole area, between that period and 1852, and gave results which may be practically taken as absolutely correct.

Since that period, the minute surveys of the land, on a very large scale, have also been completed; and upon this basis our Admiralty surveyors have constructed our present charts, by adding the soundings and maritime features outside the low-water line. The names of Mudge, Bedford, Wolfe, Beechey, Frazer, and Church, should be mentioned among the officers connected with those operations.

2. DUBLIN.—The Astronomical Observatory at Dunsink, 3 miles N.W. of Dublin, in lat. 53° 23′ 13″ N., long. 6° 20′ 30″ W., is a point verified by triangulation as well as by observation.

3. VALENTIA.—One of the most important geodetical operations in connection with the Ordnance Survey, was the chronometric determination of the difference of longitude between Valentia and Greenwich, in December, 1845. This arc, one of the largest which could be measured in the British Isles, has been of very great importance, as well in verifying the accuracy of the Trigonometrical Survey, as in determining the true figure of the earth. It was carried on by Professor Airy, the Astronomer Royal, assisted by Mr. Sheepshanks, Mr. Hartnup, Mr. Hind, and several other observers, by means of thirty pocket chronometers. The stations were Greenwich, Liverpool Observatory, a temporary Observatory at Kingstown, and Feaghmaan at Valentia. The final determination of the longitudes, chronometrically, were—Liverpool, $12^m\ 0{\cdot}05^s$; Kingstown, $24^m\ 31{\cdot}20^s$; and Valentia, $41^m\ 23{\cdot}23^s$. By the Ordnance Survey, these longitudes were made—Liverpool, $12^m\ 0{\cdot}35^s$; Kingstown, $24^m\ 31{\cdot}48^s$; and Valentia, $41^m\ 23{\cdot}07^s$.

The VARIATION of the COMPASS is now *decreasing* on the Coast of Ireland at the rate of from 6¼′ to 8′ per annum.

4. NORWAY AND SWEDEN.

	LAT. N.	LONG. E.	VAR. 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Moudiuga Island, Berezov Bar, Lighthouse	64 54 50	40 16 0	EAST. 8 15	Russian Surveys.
Swiatoi Nos, Lighthouse...	68 8 50	39 48 50		
North Cape	71 10 20	25 46 30		
Lofoten Islands, Skomvœr Lighthouse...............	67 24 15	11 54 10	WEST.	The TRIGONOMETRICAL SURVEY, made by order of the Norwegian Government, by Capt. Vibe, &c., as explained in the Notes.
Svolvaer Light	68 13 15	14 36 30	10 5	
Vaagö or N. Hellig Vaer Lt.	67 26 10	14 1 15		
Nyholmen, Lighthouse ...	67 17 15	14 24 0		
Træ Island, Söe Id., Lt.-ho.	66 25 50	11 59 50		
Andersbak Id., Lighthouse	66 15 45	12 19 0		
Mangvardkua, conical bcn.	66 13 30	12 41 20		
Donnæs öe, Church at N. end	66 12 5	12 36 30	11 0	
Björn Market-place	66 5 0	12 35 30		
Alstenö, Syv Söstre Mts., South one	65 55 0	12 32 0	11 0	
Skjærvær I., Klep Harbour	65 46 45	11 35 40		
Siola Island, summit	65 40 20	11 45 0		
Vegen I., Gulsvaagfjeld Mt.	65 39 15	11 51 0		
Vegtinden Mountain ...	65 37 45	11 54 30		
Sjelva Beacon, off Minland	65 43 0	12 19 50		
Höiholmtinderne Mount., South peak.................	65 36 0	12 26 0		
Andalshatten Mtn., S. pk.	65 33 30	12 26 0		
Kvalöe, summit	65 13 30	12 1 0	11 35	
Helgeland Offissen beacon, off Kvalöe	65 13 10	11 54 30		
Heilhornet, remarkable Mt.	65 4 32	12 9 12		
Leköe, beacon on summit	65 4 43	11 37 45		
Vigten Islands, Sulafjeld Mount....................	64 54 0	10 49 0	12 15	
Indre or Inner Island, Borvig, on East side...	64 51 30	11 15 0		
Grinna beacon	64 45 10	10 59 20		
Præstöe Light, near Næröe	64 47 25	11 7 45		
Gjöen, Brakstad	64 40 20	11 13 0		
Otter öen, Findanger Fjeld	64 36 25	11 7 0		
Halmöe, Villa	64 32 50	10 41 55	12 15	
Nordö Lighthouse...........	64 47 50	10 33 30		
Oxbaasheia, Village at S. end	64 23 45	10 30 30		
Buholmene, cone beacon...	64 25 0	10 26 20		
Vigs Sjelen, summit.........	64 15 30	10 24 0		
Osen, Church..................	64 17 45	10 31 30		
Almindingöe, Hvalhovden or South point...........	64 10 10	10 1 30		
Halten Island, Lighthouse	64 10 0	9 27 30	13 15	
Leikua Beacon, off Lysö...	63 55 40	9 58 45		
Suuls Fjord, Sulen Tower	63 50 45	8 31 45		
Fröien Island, Titterodden, or West point	63 40 5	8 19 10		

COAST OF NORWAY.

	LAT. N.	LONG. E.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Ulvö, East end	63 40 0	9 7 0		The Trigonometrical Survey, made by order of the Norwegian Government.
Great Kopperen Hill, on Mainland	63 48 15	9 45 0		
Hitteren Id., Börö Light...	63 34 20	9 14 0		
Omdasfjeld, on N. side	63 33 25	8 43 0	13 35	
Trondhjem Channel, Terningen Lighthouse ...	63 29 50	9 3 10	13 30	
Agdenæs Lighthouse ...	63 38 40	9 45 30		
Trondhjem, Munkholmen Light	63 27 30	10 23 30	12 15	
Cathedral .... [2]	63 25 49	10 23 40		
Smoelen Island, Maabergtuen, on North side	63 25 38	8 1 0		
Eddö; Trondhjem S. Channel, Light on Ringholm	63 18 45	8 14 0		
Grip Island, centre	63 13 0	7 35 40		
Brathaarskallen Lightho.	63 14 0	7 37 0		
Stavenæs Lighthouse	63 6 40	7 40 10		
Averö, Quaernaes............	63 0 20	7 44 0		
Mæknokken Mountain...	62 58 30	7 35 15		
Christiansund, Indlandet Light	63 6 0	7 43 15	14 5	
Frey öen, Frey Kollen Mt.	63 3 0	7 46 0		
Qvitholm, Lighthouse......	63 1 25	7 14 30		
Stevshest, summit	62 59 0	7 12 30		
Björnsund, Lighthouse ...	62 53 40	6 49 30		
Ona Island Lighthouse ...	62 51 45	6 33 15		
Sandö, Church	62 49 31	6 35 30		
Romsdals Oerne, Harrö Church	62 47 0	6 28 10	14 45	
Haramsö, Light at N.W. end	62 41 2	6 10 30		
Lepsörev Lighthouse	62 35 15	6 16 15		
Erknö Light	62 33 0	5 56 30		
Walderö, Light on S.E. pt.	62 29 50	6 8 5		
Godö, Lt. on Hogsten Pt.	62 27 45	6 2 10		
Light on Alnæs Tang ...	62 29 30	5 58 20		
Hessö, Sugar Loaf	62 27 30	6 6 20		
Aalesund, Light on mole...	62 28 25	6 9 30		
Grœsholmen Lighthouse...	62 25 45	5 46 0		
Rondö, Kvalnæs Lightho.	62 24 50	5 35 40	15 20	
Svinö, beacon	62 19 40	5 16 30		
Stadtland, Quitenæs at N. end	62 12 35	5 14 0		
Furenæs.....................	62 6 0	5 7 40		
Vaagsö, Skongnæs Light	62 2 0	5 7 50		
Bremanger Land, Olderveggen or West Point...	61 51 15	4 49 45		
Froe Soen, Smör Haven Lt.	61 45 45	4 56 20	15 45	
Battalen, summit............	61 38 40	4 48 0		
Ytterö Island Lighthouse	61 34 15	4 41 15		
Kindö, Lighthouse	61 33 40	4 47 0		
Bue Land, Ytsteen.........	61 17 30	4 36 10		
Udvær, Mulen	61 1 45	4 30 30		

COAST OF NORWAY.

	LAT. N.			LONG. E.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Holmengraa, beacon	60	50	30	4	39	15			The TRIGONOMETRICAL SURVEY, &c., as before stated.
Feje Oosen, Hellisö Lt.-ho.	60	45	0	4	43	0			
Holzenö, Light on Skællanger	60	36	30	4	57	15			
Bergen, Cathedral	60	23	30	5	20	20	15	15	
Observatory	60	23	50	5	18	35			
Leerö, Light on West side	60	14	15	5	10	15			
Kors Fjord, Marsteen Lt.-house	60	7	45	5	1	0			
Piir Holm, Light	60	5	10	5	11	15			
Selbö, Oxhammer Light ...	59	59	15	5	18	30			
Selbö Fiord, Furren beacon	59	58	0	5	8	15	15	10	
Slotterö Light	59	54	30	5	4	30			
Stoksund, Light on Folgerö	59	48	0	5	18	45			
Bommel Fiord, Ryvarden Light	59	31	40	5	14	0			
Roevaer Island, Light on Gitterö	59	26	5	5	7	40			
Särhougsund, N. entrance, Light	59	25	25	5	14	45			
Haugesund, Skaare Church	59	25	10	5	16	10			
Udsire Island, Lighthouse	59	18	20	4	52	30	15	0	
Karmö, Skudesnæs Lt.-ho.	59	8	20	5	17	30			
Bukkesund, Light on Bukken	59	18	25	5	27	35			
Hviddingsö, Lighthouse ...	59	3	30	5	24	20			
Stavanger, Church	58	58	12	5	45	15	14	30	
Tungenæs, Lighthouse ...	59	2	0	5	35	0			
Fladholmen Lighthouse ...	58	55	20	5	33	40			
Little Feisteen Lighthouse	58	49	30	5	30	55			
Joederens Point, beacon ...	58	45	45	5	30	30			
Obrestadbrækka, Light ...	58	39	30	5	33	30			
Warhoug, Church............	58	36	38	5	37	15			
Ekersund, Church	58	27	0	6	0	0			
Vibberodden Lt.-ho. [8]	58	25	5	5	59	35	14	15	
Ekerö, Lighthouse	58	25	50	5	52	0			
Varnæs Lighthouse	58	10	35	6	37	45			
Lister Lighthouse on Gunnarshoug	58	6	30	6	34	10			
Lindesnæs or Naze, Lighthouse	57	59	0	7	3	0	13	30	
Ryvingen, Lighthouse......	57	58	5	7	29	40			
Helleö, beacons	58	3	5	7	51	5			
Christiansand, Church......	58	9	0	7	59	50	13	0	
Odderö, Lighthouse	58	8	10	8	0	30			
Oxö, Lighthouse	58	4	25	8	3	35			
Ulvö, Outer beacon	58	6	50	8	18	5			
Justö, Beacon on Reierskjaer	58	11	50	8	23	45			
Homborgö, Gronningen Lighthouse	58	15	22	8	32	15			
Grimstad, Light	58	20	40	8	36	30			
Torungen, Outer Lightho.	58	24	5	8	47	45			
Inner Lighthouse.........	58	24	50	8	48	0			

NORWAY AND SWEDEN.

	LAT. N.	LONG. E.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Sandvigodden Lighthouse	58 26 15	8 47 25		The TRIGONOMETRICAL SURVEY, &c., as before stated.
Tromö, Church	58 27 0	8 52 15		
Tromö Sund, Bonden beacon at entrance	58 31 20	8 59 50		
Sandö, cone beacon at N.E. point	58 36 5	9 5 20	12 25	
Osterrisör, Stangholmen Lighthouse	58 42 40	9 15 0		
Sondelov, Church	58 46 0	9 5 12		
Kragerö, South end of town	58 52 0	9 24 45		The TRIGONOMETRICAL SURVEY, by Lieut. Schie, Messrs. Diriks and Wille, &c.
Jomfruland Lighthouse	58 52 10	9 36 15	12 10	
Langötangen, Lighthouse	58 59 45	9 45 50		
Frederiksværn, Staværnsö Lighthouse	58 59 35	10 3 35		
Svenöer Lighthouse	58 58 25	10 9 20		
Little Færder Lighthouse	59 1 50	10 32 0		
Fulehuk Lighthouse	59 10 45	10 36 20		
CHRISTIANIA, New Observatory	59 54 43	10 43 33	11 35	
Torbiornskiær, Light	58 59 50	10 47 20		
North Koster Lighthouse	58 54 15	11 0 37		
Segelskiær	58 46 35	11 59 50		
Stromstad Church	58 56 13	11 11 0		
Waderöbod, Lighthouse	58 32 45	11 2 15		
Hallö Lighthouse	58 20 15	11 13 20		
Maseskar Lighthouse	58 5 43	11 20 10		
Marstrand, Carlsten Light	57 53 40	11 35 0		
Winga Lighthouse	57 38 0	11 36 30	10 45	
Gotheborg Church	57 41 55	11 55 40		
COPENHAGEN, New Observatory	55 41 14	12 34 48	11 0	

NOTES.

1. COAST OF NORWAY.—The Trigonometrical Survey of the Western Coasts of Norway, to the northward of Trondhjem, was commenced by Lieut. Vibe, assisted by Lieuts. Paludan and Hagerup, in June, 1828, by order of the Norwegian Government. It was continued by those officers, under the direction of Capt. Vibe, to the frontiers of Russian Lapland, till 1849. Their elaborate charts, published at intervals, between 1835 and 1849, show the extraordinary features of this coast—a complete labyrinth of islets and rocks—of which all written descriptions must utterly fail in giving any notion. We have given the positions of the more prominent landmarks, but there are few points which can be made available for the mariner's use, except the information afforded by their valuable charts.

2. TRONDHJEM, &c.—The ancient cathedral of Trondhjem or Drontheim, once one of the finest in Europe, was the northern limit of the survey carried on by the Danish Government.

The coasts to the South were trigonometrically and astronometrically surveyed by Commissioner N. A. Vibe, before mentioned, assisted by Lieut. D'Aubert and Captain C. F. Grove, as far as Stavanger and Egefield. The charts issued under Admiral Klint (a well-known name), leave little to be desired, and the nature of the country, the geological formation being of primary gneiss, granite, and other very hard rocks, will prove that but little change can arise from the wear of the sea.

3. **Ekersund or Eggersund**, &c.—The charts of the South Coast of Norway, between Eglefield and Jedderen and Christiansand, were published in 1800. The triangulation was carried on by the same officers as before mentioned, Captains Grove and Vibe, and Lieut. D'Aubert.

This section of the coast is dependant on the positions of Stavanger and Christiansand Churches. Lindersnæs, or the Naze of Norway, as it is generally called, was made by the triangulation to be in latitude 57° 58′ 0″ N. By the astronomical observations of Messrs. Rich and Vibe, in 1781, 57° 58′ 48″ N.

Between Ekersund and Christiansand, the triangulation was re-examined in 1855-6, by Lieutenant Schie, assisted by Herr C. Diriks and Lieutenant H. Wille; between Arendal and Jomfruland, these operations were carried on by the same officers in 1853-5. The portion of coast between Arendal and Christiansand was examined in 1854-5, by Herr Diriks and Lieutenant Wille, under Major Vibe.

The Variation of the Compass is now *decreasing* on the Coast of Norway at the rate of about 9′ per annum.

5. DENMARK, GERMANY, HOLLAND, AND BELGIUM.

	LAT. N.	LONG. E.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
West Coast of Denmark.				Charts published by the Danish Government.
Skagen or Skaw Point, New Lighthouse	57 44 20	10 38 20	11 30	
Hirtshals, Lighthouse	57 35 0	9 56 33		
Lökken, Lifeboat-house	57 22 0	9 42 30		
Bolbierg Bluff (360 ft.)	57 9 7	9 2 30		
Hanstholm, Lighthouse	57 6 45	8 36 0	12 50	
Klitmölle, Beacon	57 3 0	8 31 0		
Lodberg, Lighthouse	56 49 0	8 15 45		
Rön Channel, entrance	56 43 0	8 13 20		
Bovbierg Head, Lighthouse	56 30 40	8 6 45		
Husby Church	56 17 30	8 10 15	13 5	
Ringkiöbing Church, 5 miles inland	56 5 30	8 15 0		
Nymind Gab, entrance	55 47 0	8 11 25		
Blaavands Huk, Lightho.	55 33 30	8 5 10		
Horn Reef, outer patch, 10 feet	55 32 30	7 41 5		
Horn Reef Lightvessel	55 33 10	7 19 30		
Hjerting, landing-place	55 31 35	8 21 10	12 40	
Fanö, Nordby North beacon	55 27 45	8 23 30		
Manö Church	55 16 10	8 32 30		
Romö, St. Clemens Church	55 6 55	8 32 45		
Sylt Island, Albue Head, Lighthouse	55 3 20	8 24 10	12 50	
Röde Klif, or Red Cliff Lighthouse	54 56 55	8 20 30		
Hornum Odde, Beacon	54 45 10	8 17 0		
Amrum, St. Clemens Church at Nebel	54 39 22	8 21 35		
Lighthouse at South end	54 38 0	8 21 30		

DENMARK, GERMANY, AND HOLLAND.

	LAT. N.	LONG. E.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Föhr Island, Wyk Church	54 41 25	8 34 12		Charts published by the Danish Government.
Dagebüll Harbour Lights	54 43 50	8 41 40		
Husum Church	54 28 45	9 3 10	12 15	
Ording Church	54 20 15	8 36 25		
Eiderstedt, Hitz Bank beacon	54 17 15	8 39 20		
Tönning, South Church	54 18 55	8 56 30		
Büsum Harbour	54 7 40	8 51 50		
Helgoland, Lighthouse	54 10 59	7 53 0	12 55	
Bösch Sand Beacon ... [1]	54 4 35	8 38 45		The Surveys made by the German Admiralty.
Elbe River, Outer Light-vessel No. 1	54 0 15	8 15 0	12 35	
Scharhörn Beacon	53 57 10	8 24 35		
Neuwerk Lighthouse	53 54 55	8 29 55		
Kügel or Ball Beacon	53 53 30	8 41 25		
Cuxhaven, Lighthouse	53 52 28	8 42 45		
Gluckstadt, Pier Light	53 47 10	9 24 45		
Altona, Observatory	53 32 45	9 56 39	11 45	
Hamburg, Observatory	53 33 5	9 58 31		
Weser River, Outer Lightship	53 54 15	7 49 20		
Rother Sand Lighthouse	53 51 20	8 5 5		
Hohe Weg Lighthouse	53 42 50	8 14 40		
Meyers Legde Lightho.	53 43 30	8 24 30		
Longwarden Church	53 36 20	8 18 32		
Bremerhaven, Lightho.	53 33 20	8 33 45	12 30	
Bremen, Observatory	53 4 38	8 49 0		
Jade River, Minsener Olde Oog Beacon	53 46 30	8 0 55		
Schillighorn Lighthouse	53 42 25	8 1 30		
Wilhelmshaven Observatory	53 31 52	8 8 48	12 45	
Wangeroog Lighthouse	53 47 28	7 53 59		
Church	53 47 32	7 51 5		
Spikeroog, Beacon near centre	53 46 30	7 42 40		
Langeroog, North beacon near village	53 45 10	7 29 0		
Baltrum, village at W. end	53 43 45	7 22 10		
Norderney Beacon	53 42 40	7 9 30	13 15	
Church	53 42 30	7 8 35		
Juist, Eastern Village	53 40 40	7 0 0		
Coast of Holland. [2]				
Borkum, Lighthouse	53 35 20	6 40 16	13 25	The Great Triangulation by Baron Krayenhoff, and the Surveys made by Admiral Ryk, Captains Keuchenius, Van Rhyn, &c.
Rottum, House	53 32 25	6 31 46		
Delfzyl Church	53 19 58	6 55 38		
Emden, West Church	53 22 2	7 12 15		
Schiermonnik-oog, High Lighthouse	53 29 19	6 9 42		
Ameland, Hollum Church Tower	53 26 12	5 38 15		

COAST OF HOLLAND.

	LAT. N.			LONG. E.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Ameland, North Lightho.	53	27	0	5	37	20			The Great Triangulation by Baron Krayenhoff, and the Surveys made by Admiral Ryk, Captains Keuchenius, Van Rhyn, &c.
Terschelling, Brandaris Lighthouse	53	21	40	5	12	54			
Harlingen, W. Ch. Tower	53	10	29	5	24	45			
Vlieland, Lighthouse near East end	53	17	48	5	3	31	14	20	
Posthuis near West end	53	16	5	5	58	40			
Franeker Steeple	53	11	14	5	32	42			
Makkum, Church Tower	53	3	37	5	23	59			
Bolsward, Church Tower	53	3	55	5	31	35			
Hindeloopen, Tower	52	56	37	5	23	57			
Stavoren, Church Tower	52	52	57	5	21	39			
Urk Island, Church Tower	52	39	46	5	35	38			
Vollenhoven, Station	52	40	53	5	57	4			
Muiden Church	52	19	54	5	4	11			
Amsterdam, West Tower of Cathedral [3]	52	22	32	4	53	2	14	25	
Marken Island, Light	52	27	35	5	8	30			
Enkhuisen, Church Tower	52	42	15	5	17	35			
Wieringen Island, Oosterland Tower	52	55	55	5	0	40			
Eyerland, Lighthouse at N.E. point	53	11	0	4	51	30			
Texel, Oostereind Church	53	5	5	4	52	30			
Hoorn, Church Tower	53	1	30	4	45	5			
Willemsoord, Time Signal on Palace [4]	52	57	50	4	46	36	14	30	
Kykduin Lighthouse	52	57	5	4	43	20			
Calandsoog Steeple	52	49	55	4	41	50			
Egmond-aan-Zee, Lightho.	52	37	10	4	37	20			
Ymuiden or Noord Zee Haven, South Pier-head	52	28	0	4	34	0			
Zandvoort, Lighthouse	52	22	20	4	31	38			
Nordwyk, Beacon	52	14	45	4	26	0			
Katwyk, Light	52	12	2	4	23	28			
Leiden, Observatory [5]	52	9	20	4	29	3	14	30	
Scheveningen, Lighthouse	52	6	10	4	16	0			
Hook of Holland Canal, North mole-head Light	51	59	10	4	5	5			
Voorne Island, Brielle, Light at entrance	51	54	25	4	10	40			
Hellevoetsluis, Time Signal on the Hospital	51	49	19	4	7	40	14	35	
Rotterdam, Time-ball	51	54	30	4	28	51			
Goedereede, Church Tower Light	51	49	5	3	58	38			
Iron Beacon Light, on North side	51	49	42	3	55	45			
Schouwen Island, Brouwershaven South Mill	51	43	22	3	54	40			
Renesse, East Lightho.	51	44	32	3	47	45			
Lighthouse at West end	51	42	38	3	41	30			
Zierikzee, Great Tower	51	39	2	3	54	52			

HOLLAND AND BELGIUM.

	LAT. N.	LONG. E.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Walcheren Island, Veere Great Tower	51 32 52	3 40 2		The GREAT TRIANGULATION by Baron Krayenhoff, &c.
West Kapelle, Light......	51 31 46	3 27 0		
Middelburg Tower	51 30 0	3 36 55		
Flushing or Vlissingen, Time Signal	51 26 35	3 35 48	14 50	
BELGIUM.				
Antwerp, Cathedral Tower	51 13 20	4 24 10		The FRENCH GOVERNMENT SURVEYS, &c.
BRUSSELS, Royal Observatory .... [6]	50 51 11	4 22 13	14 25	
Heijst, Light..................	51 20 25	3 14 20		
Blankenberg, Lighthouse	51 18 50	3 7 5		
Ostende, Lighthouse East of harbour	51 14 15	2 55 45	15 20	
Nieuport, Lighthouse	51 9 30	2 43 55		

NOTES.

1. ELBE AND WESER RIVERS.—The details given in the Table are taken from the Surveys of these entrances, made by the German Admiralty, based on the triangulation of Professors Gauss and Schumacher. The longitudes are dependent on that of the well-known Observatory at Altona.

2. HOLLAND.—The charts of the Coast of Holland are based upon the great triangulation of that country, by Lieut.-General C. R. T. Krayenhoff, the account of which was published in 1813. Upon the points thus established, the coasts and channels about Vlieland, Ameland, &c., were surveyed by the late Capt.-Lieut. S. J. Keuchenius, published in 1831-34; the Texel Channels, by Lieut. A. Van Rhyn, 1840; the Zuider Zee, by the same, in 1841; the Schelde Channels, by the late Vice-Admiral J. E. Ryk, 1841; Goeree and the Maas, by the same, in 1827; and Brouwershaven Gat, by Captain Keuchenius, 1826. These fine Surveys were deserving of all confidence, and have been re-examined and amended in later years by other officers.

3. AMSTERDAM.—The triangulation of Baron Krayenhoff was dependent on the position of the western tower of the Cathedral of Amsterdam, which was considered to be in longitude 4° 53′ 16·86″ E. Its longitude, by electric signal, appears to be as shown, 4° 53′ 2·55″ E. By a Government Notice, dated August 1st, 1826, Greenwich was named as the prime meridian for Netherlands hydrography.

4. TIME SIGNALS have been established at Willemsoord for the Nieuwe Diep, at Hellevoetsluis, and at Flushing, all in electric connection with the Observatory at Leiden.

5. LEIDEN.—The National Observatory of Leiden was established in 1854, under Professor Kaiser. Its longitude was obtained by electric telegraph time-signals, between Paris and Leiden, and fixed at 17m 56·60s in time, or 4° 29′ 9·0″ E. in arc, but by a very careful determination, deduced from a great number of telegraphic signals made with Greenwich, in the autumn of 1880, by M. M. Bakhuyzen, it is considered to be in 4° 29′ 3″ E.

6. **Brussels.**—The Observatory at Brussels was considered, by the observations conducted therein, to be in latitude 50° 51′ 10·7″, longitude $0^h\ 17^m\ 29{\cdot}0^s$ in time, East of Greenwich. Although this position may not affect those of the coast, which were obtained by an independent process of triangulation, yet the change in the assumed longitude of the Observatory of Paris, with corresponding alterations in the relative connexions between that and other observatories, affect the longitudes of places on the coasts, in such a minute degree, it is true, that it is perfectly inappreciable by means at the ordinary sailor's command; yet it is noticed here to show to what refinement these operations are carried on. It will also demonstrate the almost insuperable difficulty there is in arriving at an exact conclusion. This subject has been alluded to in connexion with the Edinburgh Observatory, and will be hereafter with that of Paris.

In 1859, a series of instantaneous electric signals was made to connect the Observatories of Brussels, Berlin, Altona, &c.; and the longitude of Brussels, as given by M. Quetelet, came out as $17^m\ 28{\cdot}9^s$, or 4° 17′ 30·5″ East of Greenwich—a very close approximation to the independent assumption. Later observations, however, have determined the position as given in the Table.

The **Variation** of the **Compass** is now *decreasing* on the Coasts of Denmark, North Germany, &c., at the rate of 7½′ per annum.

6. COASTS OF FRANCE.

	LAT. N.	LONG. E.	VAR. WEST. 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Northern Coast. [2]				
Paris, Observatory...... [1]	48 50 11	2 20 15	14 55	The **French Government Surveys** originated from the triangles intended merely for the admeasurement of the degrees of the meridian in France, but ultimately carried on throughout the kingdom. These were commenced by M. Picard, who effected an admeasurement between Paris and Amiens in 1669, and finally completed by Messrs. Mechain and Delambre, in 1798; after having exercised the abilities and industry of M. Cassini the elder, his son, and grandson; and since then of MM. Miraldi and de la Caille, with other of the most eminent French astronomers, &c., up to the present time.
Belgian Frontier, Corps de Garde	51 5 20	2 32 50		
Bergues, great spire.........	50 58 8	2 26 30		
Dunkirk, Belfry tower......	51 2 12	2 22 37	15 25	
Heuguenaar Tower	51 2 28	2 22 50		
Cassel, Western Mount ...	50 48 1	2 15 48		
Gravelines, Church spire...	50 59 10	2 7 44		
Oye, Station in Survey ...	50 58 43	2 2 32		
Calais Spire	50 57 33	1 51 9	15 40	
Lighthouse...................	50 57 45	1 51 20		
Coquelles, West Mill	50 55 41	1 47 53		
Cape Blanc-Nez	50 55 33	1 42 34		
Mont Couple, summit......	50 52 17	1 42 20		
Cape Gris-Nez, Lighthouse	50 52 10	1 35 0		
Ambleteuse, Windmill ...	50 48 45	1 36 40		
Boulogne, Colonne de la Grande Armée	50 44 31	1 37 0	15 45	
Cathedral	50 43 33	1 36 58		
Cape d'Alprec'h, Lightho.	50 41 57	1 33 50		
Lornel Point	50 33 33	1 34 36		
Etaples Church	50 30 52	1 38 35		
Touquet, South Light......	50 31 23	1 35 35		
Berck, Lt. on Haut-Banc	50 23 52	1 33 24		
Cayeux, Lighthouse.........	50 11 42	1 31 0		
St. Valery-sur-Somme, Lt.	50 11 30	1 37 40		
Tréport Steeple...............	50 3 39	1 22 30		
Dieppe, Semaphore.........	49 56 0	1 5 35		
St. Jacques Church	49 55 35	1 4 38	15 50	

NORTH COAST OF FRANCE.

	LAT. N.	LONG.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
		EAST.		
Pointe d'Ailly, Lighthouse	49 55 7	0 57 35		The French Government Surveys.
St. Valery en Caux, Chapel	49 52 12	0 42 57		
Fécamp Abbey	49 45 22	0 23 15		
Cape d'Antifer	49 41 10	0 10 0		
Cape La Héve, N. Lightho.	49 30 50	0 4 25		
Le Havre, Steeple of Notre Dame	49 29 15	0 6 45	16 10	
Honfleur, Western Light	49 25 32	0 13 45		
Rouen, Bridge	49 26 25	1 5 20		
		WEST.		
Oyestreham Church	49 16 33	0 15 20		
Pointe de Ver, Light	49 20 30	0 30 50		
Port en Bessin, Light	49 21 0	0 45 10		
St. Marcouf Isles, Lightho.	49 29 55	1 8 40		
Fort La Hougue, Lightho.	49 34 27	1 16 25		
Cape Barfleur, Lighthouse	49 41 50	1 15 35		
Cape Levi, Lighthouse	49 41 50	1 28 15		
Cherbourg, Central Fort on the Digue	49 40 28	1 37 0	17 0	
Querqueville Spire	49 39 55	1 41 45		
Cape La Hague, Lightho.	49 43 21	1 57 10		
Alderney, Braye Harbour, end of mole	49 43 55	2 11 25	17 10	The Survey by Captain Martin White, R.N., and Mr, Richards, &c.
Casquets, Lighthouse	49 43 15	2 22 42		
Guernsey, St. Pierre North Pier-head	49 27 25	2 31 40	17 15	
Hanois Rocks, Lighthouse	49 26 5	2 42 0		
Jersey; St. Helier, Elizabeth Castle	49 10 33	2 7 18	17 0	
Corbière Rocks Lightho.	49 10 40	2 14 50		
Chausey Island, Lightho.	48 52 18	1 49 10		The excellent Surveys of the Coast by the French Engineers, under the direction of M. Beautemps Beaupré, in 1830—1831, and later surveys.
Cape Carteret, Lighthouse	49 22 27	1 48 20		
Granville, Lighthouse	48 50 7	1 36 45		
St. Malo, Light	48 38 35	2 1 30		
Cape Frehel, Lighthouse	48 41 5	2 19 0	17 0	
Le Rohinet Islet	48 40 33	2 23 35		
Cape d'Erqui	48 38 45	2 29 10		
Les Comtesses, Western Rock	48 38 58	2 34 20		
Grand Léjon Rock, Lt.-ho.	48 45 5	2 39 50		
Harbour Isle, off St. Quay	48 40 2	2 48 25		
Isle Bréhat, Paon Point Lighthouse	48 52 0	2 59 0		
Héaux de Bréhat, Lightho.	48 54 33	3 5 10	17 25	
Roches Douvres, Lightho.	49 6 30	2 48 50		
Tréguier River, La Corne Rock Lighthouse	48 51 20	3 10 25		
Les Sept Iles, Lighthouse	48 52 46	3 29 15		
Triagoz Lighthouse	48 52 25	3 38 55		
Ile de Bas, Lighthouse near the West end	48 44 45	4 1 25		
Pointe de Pontusval, Lighthouse	48 40 45	4 20 45		

WEST COAST OF FRANCE.

	LAT. N.			LONG. W.			VAR. WEST, 1895.	
	°	′	″	°	′	″	°	′
Chenal du Four, Lightho.	48	31	20	4	48	5		
Ouessant, or Ushant, N.E. Lighthouse	48	28	30	5	3	15	18	15
The Bay of Biscay.								
Les Pierres Noires Lighthouse	48	18	40	4	54	45		
Lampaul Church	48	33	40	4	39	15		
Kermorvan, Lighthouse	48	21	44	4	47	15		
St. Mathieu, Lighthouse	48	19	49	4	46	10		
Portzic, Lighthouse	48	21	33	4	32	15		
Brest, St. Louis Church	48	23	20	4	29	30	17	55
Crozon Church	48	14	48	4	29	20		
Toulinguet Point Lightho.	48	16	45	4	37	45		
Tevennec Rock Lighthouse	48	4	20	4	47	40		
Bec du Raz, West extreme	48	2	22	4	44	20		
Ile de Sein, Lighthouse	48	2	35	4	51	55		
Ar-men Rock, Lighthouse	48	3	0	4	59	50	18	5
Penmarc'h Lighthouse	47	47	53	4	22	25		
Penfret Lighthouse	47	43	17	3	57	10	17	30
Ile de Groix, Western Lt.-house	47	38	55	3	30	30		
Port Louis, East point of entrance	47	42	45	3	21	45		
Belle Ile, Lighthouse on S.W. Point	47	18	43	3	3	33	17	0
Lighthouse off North end	47	23	20	3	15	5		
Grands Cardinaux, Lt.-ho.	47	19	20	2	50	5		
Le Four, Lighthouse	47	17	50	2	38	0		
Aiguillon, Lighthouse	47	14	40	2	15	45		
Saint Nazaire, entrance	47	16	30	2	11	40		
Pilier, Lighthouse	47	2	30	2	21	30		
Ile d'Yeu, Lighthouse	46	43	5	2	22	55	16	35
St. Gilles sur Vie, Mole Lt.	46	41	46	1	56	45		
La Chaume, Lighthouse	46	29	42	1	47	50		
Sables d'Olonne, Jetty Lt.-house	46	29	30	1	47	20		
Ile de Ré, Baleine Lt.-ho.	46	14	44	1	33	40		
Port of St. Martin	46	12	26	1	22	0		
Port de la Pallice, North Pier Light	46	9	35	1	13	30		
Rochelle, Harbour Light	46	9	21	1	9	0	16	10
Ile d'Oleron, Chassiron Lt.-house	46	2	52	1	24	37		
Ile d'Aix, Harbour Light	46	0	36	1	10	35		
Pointe de la Coubre, Light	45	41	40	1	15	20		
Port of Royan, Light	45	37	18	1	1	35		
Cordouan Lighthouse	45	35	14	1	10	20		
Pauillac, Harbour Light	45	11	55	0	44	40		
Bordeaux, Observatory	44	50	17	0	31	21	15	30
St. André Church	44	50	16	0	34	30		
Pointe de Grave, Lightho.	45	34	10	1	3	55		
Hourtin Lighthouse	45	8	25	1	9	40		

AUTHORITIES.

The Hydrographic Surveys of the Western Coasts of France, made by the French Engineers, under the direction of M. Beautemps Beaupré, with later observations.

Remarks.

It is to be remarked, that the longitudes, as given in the *Connaissance des Temps*, compared with those in the Charts of the *Pilote Français*, constructed between 1816 and 1827, under the direction of M. Beautemps Beaupré, showed a difference amounting to, at the least, 51·5″, the former Survey being so much less, which was occasioned by the later determination of the geographical position of Crozon, near Brest, as explained in the note. The longitudes given in the Table are corrected.

WEST COAST OF FRANCE.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Cap Ferret, Lighthouse ...	44 38 30	1 14 50		The **French Hydrographic Surveys.**
Contis, Lighthouse	44 5 45	1 19 0		
Cap Breton, Lighthouse ...	43 39 20	1 26 40		
River Adour, Outer Light	43 31 36	1 31 10		
Bayonne, Bridge	43 29 40	1 28 10		
Biarritz, Lighthouse.........	43 29 38	1 33 0		
Socoa, Harbour Light......	43 23 44	1 40 50	15 45	
St. Jean de Luz, Jetty Lt.-house	43 23 20	1 40 5		

NOTES.

1. **Paris.**—The grand operations, in point of accuracy, for the determination of the length of the degrees of the meridian, have taken place since 1783. In that year a memorial was transmitted by M. Cassini de Thury to the Right Hon. Charles James Fox, then Secretary of State. This application caused the operations by General Roy, already explained, which afterwards extended into a General Survey. This gentleman, in England, acted in conjunction with Messrs. Cassini, Mechain, and Legendre, in France; but it unfortunately happened that the results of the two parties did not exactly agree—that of the British being, for the difference of longitude, 2° 19′ 51″, while that of the French was 2° 20′ 15″.

In order to determine this question, the subject was resumed in 1821, on the suggestion of the French authorities. The operations were consequently repeated under the direction of commissioners, nominated respectively by the Academy of Sciences and the Royal Society. An account of the operations and results were given in the "Transactions" of the latter, and the determination was that 2° 20′ 22″ was the difference between the meridians of Paris and Greenwich. It was also attempted, in 1825, by the respective governments on a plan suggested, we believe, by the late Sir John Herschel, and Captain (afterwards General Sir Edward) Sabine, and Colonel Bonne, of simultaneous observations of rocket signals at a chain of stations; but they failed on the French side, and the result, 2° 20′ 22″, was not considered satisfactory.

Notwithstanding the immense labour and consummate skill employed in these measurements, the results obtained were doubtful, and it was reserved for the private means of a commercial association to make another attempt to settle the question by means of the electric telegraph. The death of M. Arago delayed the French preparations which were organized when M. le Verrier became Superintendent of the Paris Observatory, and several thousand signals were transmitted in 1854, so many, in fact, that a large portion were rejected, leaving 1,700, or nearly 2,000, which were thought unexceptionable. Each observation was probably as accurate as the mean of all former observations, and the means of all showed previous results to be in error nearly a second of time (a large quantity in astronomy).

The mean result of these electric observations was that the D. L. between Greenwich and Paris Observatories is $9^{m}\ 20{\cdot}63^{s}$ of time, or 2° 20′ 9·45″ in arc. Later observations, however, place it in 2° 20′ 15″.

We have been more diffuse, perhaps, than necessary on this point, but it is one of the most important geodetical operations ever undertaken.

2. The re-examination of the Northern Coasts of France and the triangulated Survey of the Western shores was originated in 1814, by a memorial addressed to Louis XVIII. by Admirals Rosily and Rossel, but from political events it was not commenced till 1816, and then M. Beautemps Beaupré started the survey from Brest. The triangulation was based upon the carefully observed position of the Tour de Crozon, and carried out by M. Daussy down to the frontiers of Spain. The noble Atlas is the best eulogy that can be presented for these important works.

The Variation of the Compass is now *decreasing* on the Coast of France, at the rate of about 7′ 30″ per annum.

7. COASTS OF SPAIN AND PORTUGAL.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
North Coast of Spain. [1]	° ′ ″	° ′ ″	° ′	
Cape La Higuera, Lightho.	43 23 20	1 47 50	15 50	The valuable Surveys of Don Vicente Tofiño and Don Josef Varela, of the Spanish Marine, and of Major Franzini, of the Portuguese Royal Engineers, corrected by later observations of M. Saulnier de Vauhello, Captain Florez, Captain W. H. Smyth, R.N., and others.
Fuenterrabia	43 21 46	1 47 30		
Port Pasages, Cape La Plata Lighthouse	43 20 5	1 56 30		
San Sebastian, Mt. Igualdo Lighthouse	43 19 17	2 0 43	16 0	
Guetaria, Lighthouse	43 19 0	2 13 0		
Motrico, Atalaya	43 19 30	2 24 45		
Cape Machichaco, Lighthouse	43 27 45	2 49 26	16 5	
Punta Galea, Lighthouse	43 22 36	3 4 10		
Portugalete	43 20 0	3 3 45		
Bilbao, Arenal Bridge	43 16 10	2 57 50	16 5	
Castro Urdiales, Santa Ana Castle Light	43 24 10	3 16 6		
Santoña, Lighthouse on N.E. Pescador Point	43 28 30	3 27 30		
Cape Ajo, extreme	43 31 30	3 37 0		
Santander, Mouro Island Lighthouse	43 28 37	3 45 30		
Harbour	43 27 52	3 48 7		
Cape Mayor, Lighthouse	43 29 45	3 47 6	16 30	
San Martin de la Arena, Torco de Afuera Light	43 26 49	4 1 4		
Suances Church	43 26 10	4 0 45		
Cape Oyambre, extreme	43 25 15	4 20 55		
San Vicente de la Barquera, Lighthouse	43 24 45	4 24 30		
Llanes, Lighthouse	43 26 30	4 45 30		
Cape Prieto, N.W. extreme	43 28 48	4 52 0		
Sella River, Somos Point Lighthouse	43 31 0	5 7 20	17 5	
Cape Lastres	43 34 20	5 18 30		
Gijon, Santa Catalina Point Lighthouse	43 35 30	5 38 2	17 20	
Cape Torres	43 37 0	5 40 0		
Cape Peñas, Lighthouse	43 42 0	5 49 45	17 25	
Aviles River, Lighthouse	43 38 5	5 56 0		

COASTS OF SPAIN.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Cudillero, Revallera Point Light	43 36 10	6 8 30		The Charts published by the SPANISH GOVERNMENT, &c.
Cape Bidio, extreme	43 37 45	6 15 15		
Cape Busto, Lighthouse	43 36 10	6 27 30		
Ria de Navia, Campel Point	43 34 45	6 43 15		
Orrio de Tapia Island, Lt.-house	43 35 36	6 56 26	17 50	
Rivadeo, Pancha Island Lighthouse	43 34 40	7 4 15		
Foz, Point de los Cairos	43 35 45	7 14 30		
San Ciprian, Lighthouse	43 43 0	7 25 45		
Port Vivero, Socastro Point	43 43 28	7 36 30		
Estaca Point, Lighthouse	43 47 15	7 41 30		
Cape Ortegal, extreme	43 46 10	7 54 30	18 15	
Candelaria Point, Tower	43 42 10	8 2 20		
Cedeira, Robaleira Point Lighthouse	43 39 0	8 4 10		
Cape Prior, Lighthouse	43 33 40	8 18 30		
Cape Prioriño, Lighthouse	43 27 30	8 20 15		
Ferrol, West Mole [2]	43 28 35	8 14 25		
Coruña, Tower of Hercules Light	43 23 15	8 24 20	18 20	
St. Antonio Castle	43 22 0	8 23 15		
Sisargas Islands, Lt.-house on Isla Mayor	43 21 45	8 50 20	18 30	
Cape Villano, Lighthouse	43 9 50	9 12 58		
Camariñas, Mole	43 8 0	9 11 30		
WEST COAST OF SPAIN.				
Cape Toriñana, N. extreme	43 4 20	9 17 45		
Cape Finisterre, Lighthouse on South extreme	42 52 59	9 15 24	18 30	
Corcubion, Lt. on Cape Cé	42 54 50	9 10 5		
Remedios Point, extreme	42 47 45	9 8 15		
Muros Bay, Queijal Point Lighthouse	42 44 10	9 4 0		
Cape Corrobedo, Lightho.	42 34 30	9 4 48		
Arosa Bay, Santa Eugenia Church	42 33 0	9 58 45		
Salvora Island, Light on South point	42 28 10	9 0 26	18 15	
Carril Church	42 36 40	8 45 30		
Arosa Island, Light on North point	42 34 8	8 52 30		
Onza Island, Lighthouse	42 22 30	8 55 30		
Pontevedra Bay, Cape Udra	42 20 0	8 49 15		
Pontevedra, centre	42 25 30	8 37 50		
Bayona or Cies Islands, Caballo, or N. Point	42 14 50	8 53 25	18 10	
Middle Island, Light on Mount Faro	42 12 30	8 53 54		
Boeiro Island, off South end	42 10 12	8 52 56		

COASTS OF SPAIN AND PORTUGAL.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Vigo Bay, Cape Hombre, rock off	42 14 45	8 52 0		The Charts published by the SPANISH GOVERNMENT, &c.
Vigo, Castro Castle	42 13 35	8 42 30	18 5	
N.S. de la Guia Castle, Light	42 15 6	8 41 50		
Cape Sentoulo, Mount Ferro	42 8 50	8 50 0		
Bayona Church	42 6 45	8 49 0		
Cape Silleiro, Lighthouse	42 6 0	8 53 0		
Orullada Point, extreme	42 1 30	8 53 30		
Minho River, Mount St. Tecla Chapel	41 52 50	8 52 15		
COAST OF PORTUGAL.				
River Minho, Castillo Point	41 51 30	8 52 0	18 0	
Viana, Castello de Santiago	41 41 25	8 50 15		
River Neiva, entrance	41 37 0	8 47 30		
Espozende, Light	41 32 30	8 47 0		
Villa do Conde	41 21 30	8 45 0		
Leixoes Harbour, Castle	41 11 30	8 42 30		
River Douro, Light at N.S. da Luz [3]	41 9 9	8 40 34		Capt. Sir Edward Belcher, R.N., 1833, and later Surveys.
Oporto, Bridge	41 8 15	8 36 30	17 50	
Aveiro, Barra Nova	40 38 45	8 45 0		
COIMBRA, Observatory	40 12 26	8 23 37		
Cape Mondego, Lighthouse	40 10 45	8 54 30		
Peniche, Lighthouse on Cape Carvoeiro	39 21 45	9 24 0		
Berlengas, Light on Great Island	39 25 2	9 30 28	17 45	
Farilhoens, centre	39 29 0	9 31 56		
Cape Roca, Lighthouse	38 46 50	9 29 45		
Tagus River, Bugio Fort Light	38 39 20	9 17 45		
LISBON, Royal Observatory [4]	38 42 31	9 11 10	17 30	U. S. Officers, 1878-9.
Cape Espichel, Lighthouse	38 24 45	9 13 0		
Setubal or St. Ubes, Light on Fort d'Outao	38 29 30	8 56 0		
Cape Sines, Lighthouse	37 57 30	8 53 0		
Cape Sardao	37 31 0	8 49 30		
Cape St. Vincent, Convent Light	37 1 20	8 57 45	17 10	
Gorringe or Gettysburg Bank, shoalest spot of 30 fathoms	36 31 30	11 35 30	17 50	
Lagos, Piedade Point	37 4 40	8 38 15		
Villa Nova de Portimao	37 7 0	8 31 10		
Baliera Point, Light	37 4 30	8 15 30		
Cape Santa Maria, Light	36 58 15	7 49 50	16 50	

SOUTH COAST OF SPAIN.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
South Coast of Spain.				
Guadiana River, Ayamonte Mouth, Light on W. side	37 11 10	7 24 0	16 45	The Charts published by the Spanish Government, &c.
Odiel River, Lights	37 7 30	6 49 0		
Huelva, Observation Spot near West end of town	37 15 9	6 57 4		
Guadalquivir River, Punta de Malandar Light ...	36 47 30	6 21 20		
San Lucar de Barrameda, Light	36 46 5	6 22 20		
Chipiona, Light...............	36 44 0	6 26 30		
Cadiz, San Fernando Observatory .... [5]	36 27 41	6 12 24	16 20	
San Sebastian Castle Lt.	36 31 20	6 18 54		
Cape Trafalgar, Lighthouse	36 10 45	6 2 12		
Punta Gracia, Tower	36 5 5	5 48 58		
Mount Sella del Papa, summit (1,567 ft.).........	36 6 16	5 47 0		
Point Paloma	36 3 15	5 42 40		
Tarifa, Lightho. on South point	35 59 47	5 36 45		
Punta Acebuche	36 2 48	5 28 15		
Carnero Tower	36 4 30	5 25 50		
Algesiras, Verte Island Lt.	36 7 15	5 26 16		
Gibraltar, Dockyard Flagstaff .... [6]	36 7 20	5 21 27	16 0	
Europa Point, Victoria Lighthouse	36 6 22	5 21 0		

NOTES.

1. The North Coast of Spain.—The whole of the North Coasts of Spain were excellently surveyed and delineated by Don Vincente Tofiño de San Miguel, in the years 1787-91; at the same period that our hydrography was being enriched by the talent and labours of Mackenzie, Spence, and others. The Spanish charts, still most useful, exhibit the minute details of this ironbound coast with such fidelity, that but little change has been found necessary upon re-examination. This, doubtless, is in some degree owing to the geological structure of the country, which, devoid of sloping beaches, presents a much more effective barrier to the degrading action of the sea; while the S.W. Coast of France, at the bottom of the Bay of Biscay, is embarrassed by those immense collections of sand, &c., the débris of the coasts to the West of it, which is carried thither by the prevalent wind, waves, and currents.

But while the details of this Survey are so excellent, later and more correct observations show that there are some great errors in the relative position of the principal points. This was detected, among other operations, by the early observations of M. Bory, and perhaps by the Spanish Surveys, which were taken possession of by the French, at the investment of Madrid. Later, the survey made by M. Saulnier de Vauhello, of the French Marine, showed that Cape Machichaco was placed nearly 10′ too far eastward, and other points from 4′ upwards, also too far to the East. These great errors are now, if not entirely removed, so nearly adjusted, that the discrepancies are too small to affect navigation. The positions, especially the longitudes, given in the Table, are in accordance with the latest observations.

2. **Coast of Galicia.**—The N.W. Coast of Spain was re-examined by Captain Don J. F. Florez, of the Spanish Navy, in 1835-6. His survey, with more recent examinations, seems to show the accuracy of his predecessor Tofiño.

3. **River Douro.**—This river was surveyed by Commander (afterwards Sir Edward) Belcher, R.N., in 1833. His determinations, which coincide with those made by Admiral Smyth, when a lieutenant, in 1811-12, served to correct the positions previously given by Tofiño. In former editions of this work, we had to acknowledge our obligations in this, as in many other instances, to Admiral Smyth, for his improvements in hydrography. It is sufficient here to repeat them.

4. **Lisbon.**—The longitude of Lisbon was assumed as 9° 8′ 40″ W., the mean result of observations made by the astronomers De la Caille, Pingré, and Messier, of a great number of eclipses of the first satellite of Jupiter. The occultation of a star by the moon, October 5, 1758, with a corresponding one at Paris, gave one minute more. Captain Owen, in the memoir of his important expeditions to Portugal and Africa, assigned to the Arsenal of Lisbon, lat. 38° 42′ 18″ N., long. 9° 8′ 54″ W., from observations made in H.M.S. *Leven*, in 1819 and 1822. Later observations placed it in 9° 7′ 31·8″, and the present charts are dependent on the latter position.

By telegraphic determinations, made by United States Officers, in 1878 and 1879, in connection with establishing secondary meridians for the East Coast of South America, the longitude of the dome of the Royal Observatory was ascertained to be 9° 11′ 10·2″ W. The latitude is determined to be 38° 42′ 31·25″ N.

5. **Cadiz.**—The position of the Observatory in the city of Cadiz is established as lat. 36° 32′ 0″ N., long. 6° 17′ 30″ W. The New Observatory (*Observatorio Real*) of San Fernando, in the Isle of Leon, is in lat. 36° 27′ 41″ N., long. 6° 12′ 24″ W.

6. **Gibraltar.**—This position is important, as it affects the longitudes of the West Coast of Africa. Mr. Charles Rumker gave the position of Europa Point, Gibraltar, as 36° 5′ 15″ W.—(*Edinburgh Philosophical Journal*, vol. i., page 322). Captain Bauza, of the Hydrographic Establishment at Madrid, gave Tarifa in 36° 0′. This accords with Mr. Rumker; but Captain Livingston made the latitude of Europa Point, by sextant and artificial horizon, in 1820, 36° 6′ 10″, and exactly the same on another day, by the sea horizon. Captain Smyth gave Gibraltar in lat. 36° 6′ 30″ N., long. 5° 21′ 12″ W.

It is to be observed that Lieutenant Raper adopted 5° 21′ 17″ as the longitude of the Mole (or Europa Point in 5° 22′ 0″), and this was from the observations of Capt. Smyth; Capt. Shirreff, 5° 20′ 16″; and Capt. Vidal, 5° 21′ 42″. By telegraphic communication with Malta, in 1886, the officers of H.M.S. *Sylvia* determined the longitude of the Dockyard Flagstaff to be 5° 21′ 27″ W.

The **Variation** of the **Compass** is now *decreasing* on the Coasts of Spain and Portugal, at the rate of about 6′ per annum.

8. THE WEST COAST OF AFRICA.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Ceuta, Almina Point Light	35 53 38	5 17 3	15 55	Capt. C. P. de Kerhallet, M.C.A. Vincendon-Dumoulin, Captain Washington, Lieut. Smith, Captain T. Boteler, Lieutenants Wm. Arlett and H. Kellett, R.N., Don Juan Badia y Leblich, otherwise called Ali Bey, 1804, the Chevalier de Borda, &c., &c.
Sierra Bullones or Apes Hill (summit)	35 53 35	5 25 0		
Tangier Bay, Cape Malabata, Tower	35 48 50	5 45 0		
Tangier, N.E. part of town	35 47 5	5 48 40		
Cape Spartel, Lightho. [1]	35 47 0	5 55 15		
Arzilla	35 29 0	6 1 0		
El Araiche, Fort	35 13 0	6 7 30	16 15	
Old Mamora, Large Tomb	34 55 0	6 17 45		
Mehedia	34 18 30	6 38 0		
Faz or Fez	34 5 0	4 56 0		
Mekinez	33 53 30	5 29 0		
Slaa or Salee, Fort	34 4 30	6 48 30		
Rabat, Hassan Tower	34 3 30	6 48 0	16 25	
El Mansoria [2]	33 46 10	7 16 0		
Cape Fedala	33 44 20	7 22 15		
Dar-el-Beida, Ruined Fort	33 37 0	7 32 50		
Azamor	33 17 37	8 16 30		
Mazagan, English Consulate	33 15 32	8 30 42		Comm. Dawson, R.N., 1886.
Cape Blanco North	33 8 0	8 36 15	16 50	
El Waladia	32 44 20	8 59 0		
Cape Cantin	32 32 50	9 14 20		
Asfee or Saffi, Castle	32 17 56	9 10 47		
Marocco, centre [3]	31 38 0	7 36 0	16 35	
Suerrah or Mogador	31 30 52	9 46 30	17 5	
Cape Tefelneh	31 6 0	9 47 30		
Cape Ghir or Ras Aferni	30 38 0	9 50 0		
Agadir or Santa Cruz, Minaret	30 27 0	9 34 35		
Cape Aguluh	29 49 0	9 48 30		
Cape Nun or Inoon	28 45 45	11 1 0		
Porto Cansado, entrance	28 3 45	12 10 30		
Cape Juby, Fort	27 56 41	12 56 5		Commander Dawson, 1886.
False Cape Boiador	26 25 15	14 7 30		
Cape Boiador or Bojador [4]	26 7 2	14 30 20	17 50	
Penha Grande, summit	25 6 30	14 49 30		
Seven Capes, Central Cape	24 41 12	15 0 30		
Angra dos Cavallos	24 3 12	15 40 0		The Observations of Capt. W. Fitzwilliam Owen, M. le Baron Roussin, &c.
Rio do Ouro, Durnford or North Point	23 37 59	16 0 20		
Cintra Bay, North point	23 6 30	16 12 30		
Cape Barbas	22 20 30	16 45 0	18 25	⁂ In 1830, Captain (afterwards Adm. Sir Edw.) Belcher, by repeated observations, found Cape Blanco in lat. 20° 46′ 26″, long. 17° 4′ 10″.
Pedra da Gall, centre	22 18 15	16 54 0		
Cape Corvoeiro	21 46 44	17 0 0		
Cape Blanco	20 47 0	17 2 50	18 25	
Cape Arguin	20 32 15	16 34 15		French Survey, 1888.
Cape Mirik, the Down	19 23 0	16 32 30		
Tanit Bay, the Down	19 3 48	16 12 20		H.M.S. *Esk*, Capt. Purchas.
Angel's Hillocks, Southern	18 29 30	16 3 0		

THE WEST COAST OF AFRICA.

	LAT. N..	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Portandik	18 15 0	16 6 47	18 20	Captain (afterwards Admiral and Baron) Roussin, and later French Surveys.
Down of Red Sand	17 25 0	16 9 0		
Second ditto	16 55 0	16 21 0		
Huts of Inguiagher	16 35 24	16 30 0		
St. Louis, Senegal, Light on Government House	16 0 48	16 33 40	18 35	
Bar of the Senegal, North point	15 55 18	16 35 0		
Little Paps, near Cape Verde, northern one	14 56 24	17 8 0		
Cape Verde, Light on extremity	14 45 0	17 32 30	18 50	
Dakar, Petit Paris	14 41 17	17 26 0		
Cape Manuel, Light	14 38 45	17 27 0		
Goree, the Fort Lighthouse	14 39 50	17 24 30		
Rufisque, Light	14 42 40	17 17 57		French Survey, 1876.
Cape Naze	14 32 0	17 7 20		Capts. Owen & Boteler, R.N.
Portudal, Village	14 27 18	17 3 12		
Point Serine	14 17 15	16 56 30		
Joal, Town	14 9 30	16 49 45		
River Gambia :				
Bathurst Town, Battery Flagstaff	13 27 25	16 34 30	18 55	Survey of the River Gambia, from its entrance to Pisania, by Capt. Richard Owen, R.N., assisted by Messrs. E. O. Tudor and S. M. Mercer, H.M.S. *Leven*, 1826, the Officers of H.M.S. *Sylvia*, 1886, &c.
Cape St. Mary	13 29 25	16 40 3		
James Fort	13 19 5	16 21 25		
Thankrowell or Tankural	13 24 30	16 3 48		
Elephant Isle, West Pt.	13 27 0	15 20 36		
Yamamaroo Town	13 42 0	14 58 30		
M'Carthy Island, Fort George	13 33 0	14 45 30		
Pisania or Pisaneea	13 31 54	14 34 18		
Bald Cape	13 22 20	16 48 35		
Point St. Pedro	13 4 30	16 46 30		
River Souta, Bird Islet	12 48 30	16 47 45		Capt. Thos. Boteler, H.M. sloop *Hecla*.
River Casamanza, North point of the entrance	12 35 20	16 47 30		
Cape Roxo	12 20 30	16 45 50	19 5	
Rio Cacheo, Breakers of Falulo, West part	12 10 0	16 44 0		Capts. Roussin and W. F. Owen.
Parcels Breakers, West part	12 4 0	16 44 15		
Isle of Cayo, West point	11 51 0	16 22 0		
Bissao, Portuguese Fort	11 52 0	15 36 30	19 0	
Bijooga Islands, &c. :				
Papagaio Islet	11 36 15	15 58 45		Survey of the Bijooga Islands, and the adjacent Coast of Africa, by the officers of H.M.S. *Leven*, Capt. W. F. Owen, &c.
Arcas Isle, centre	11 42 30	15 37 0		
BubaFactory,RioGrandy	11 36 0	14 59 30		
Bulama Island, East end	11 33 15	15 27 30		
Bossessamé, or Tombelle, North point, Factory	11 29 30	15 28 30		
S.W. point	11 19 24	15 29 45		
Gallinha Isle, West point	11 27 42	15 44 30		
N.E. Hog Island, East point	11 20 0	15 38 15		

THE WEST COAST OF AFRICA.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
Bijooga Islands (*continued*).	° ′ ″	° ′ ″	° ′	
Kanyabac, Barel or East point	11 13 30	15 39 15	19 5	Survey of the Bijooga Islands, and the adjacent Coast of Africa, by the officers of H.M.S. *Leven*, Capt. W. F. Owen, &c.
S.W. point	11 10 0	15 46 0		
Orango, S.E. point	11 2 30	15 53 0		
West point	11 5 30	16 15 30		
South Breaker	10 40 0	16 8 30		
Bijooga Breaker, West end	11 30 30	16 57 15		
Pullam Islet, South point	10 51 45	15 43 30		⁂ In 1830, Capt. (Sir Edw.) Belcher, in H.M.S. *Etna*, from his observations, made Pullam Islet, S. end, in lat. 10° 51′ 53″ N., long. 15° 43′ 5″ W.; North end of Alcatraz, in lat. 10° 38′ 1″ N., long. 15° 20′ 30″ W.; Sandy Isle in lat. 10° 36′ 37″ N., long. 14° 42′ 19″ W.—*Geo. Journal*, vol. ii., pp. 284, 291, 295.
Alcatras Islet, centre	10 37 45	15 21 0		
Conflict Reef, 2¼-fathoms patch off South Prong	10 16 30	15 5 20		
Rio Nunez, Entrance, Sand Islet	10 36 37	14 41 10		
Boke, English Factory	10 52 30	14 15 0		
Cape Verga, summit	10 11 40	14 28 5		
Ponga River, entrance, W. point	10 3 30	14 4 30	19 5	
Mount Kakulimah	9 45 0	13 27 45		
Isles de Los:				
Crawford Isle, Observation Spot	9 27 24	13 48 30		
Tamara, Arethusa or N. Point	9 30 30	13 49 30		
White Islet	9 25 20	13 47 15		
Matacong Island, centre	9 16 5	13 26 15		Captain W. F. Owen and Captain Purchas, corrected by later Surveys.
Yellaboi Island, centre	8 57 0	14 17 45		
Kakonkah Island, centre	8 54 0	13 9 50		
Cape Sierra Leone, Lighthouse [5]	8 30 10	13 18 5	19 15	
Sierra Leone, Freetown, Citadel	8 29 42	13 14 45		
False Cape, extremity	8 25 48	13 17 48		
Cape Chilling, or Shilling	8 10 15	13 9 50		
Banana Isles, highest peak	8 5 48	13 13 45		
West Point	8 5 20	13 15 0		
Plaintain Ids., Gillmorris	7 55 12	13 0 0		
Bengal Rocks	7 55 0	13 2 48		
Tassa Point, extremity	7 55 45	12 58 10		
Turtle Isles; North Island, centre	7 40 15	13 3 50		
Cape St. Anne, extremity	7 34 0	12 57 45	19 20	
Shoals of St. Anne, N.W. Patch, 2¼ fathoms	8 0 15	13 34 0		
York Isle, in Sherbro' River, N.E. point	7 32 0	12 28 0		
Argyle Point, Shebar River	7 28 20	12 32 15		
Boom Kittam River, Forks	7 20 0	12 4 30		
River Galinhas, Kamasoun Island, West elbow	7 0 8	11 38 55		Capt. A. T. E. Vidal, H.M. ships *Etna* and *Raven*, and later Surveys.
Cape Mount, Western Beach	6 44 30	11 23 20	19 15	
St. Paul's River, entrance	6 23 0	10 49 0		
Cape Mesurado, Lightho.	6 19 10	10 49 25		

THE WEST COAST OF AFRICA.

	LAT. N.	LONG.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
		WEST.		
Monrovia, Govt. House ...	6 19 5	10 48 55	19 15	Capt. A. T. E. Vidal, H.M. ships *Ætna* and *Raven*, and later Surveys.
Junk River, Marshall, Agent's House	6 8 6	10 22 45		
Grand Bassa, Agent's House	5 54 50	10 4 5		
River Sestros, or Grand Cestos, Factory on St. George Point...............	5 26 25	9 34 45		
Baffou Point	5 9 10	9 17 30		
Bloo Bara, or Barbarra Factory, Sinou	4 59 15	9 2 5		
Middle Neefoo, or Niffou...	4 45 8	8 33 15		
Garraway	4 30 0	7 56 30		
Cape Palmas, Lighthouse	4 22 9	7 44 16	19 0	
Tabou	4 25 0	7 21 30		
Grand Bereby, Bluff	4 39 8	6 54 10		
St. Andrew's River, King George's Town, within Swartou Corner	4 57 45	6 8 47		
River Fresco, or Rio de Lagos, Mouth	5 5 0	5 33 15	18 15	
Grand Lahou, East end ...	5 8 45	4 57 40		
Jack Jack	5 11 45	4 26 8		
Grand Bassam, Bar	5 11 0	3 42 15		
Assinee River, entrance [6]	5 8 45	3 28 10	17 45	
Apollonia, Fort..............	4 58 45	2 35 5		
Axim, Fort St. Anthony...	4 52 18	2 14 45		
Cape Three Points, Lt.-ho.	4 44 50	2 5 45	17 30	Captains Vidal, Owen, Purchas, Kelly, Denham, and other and more recent observers, including the officers of the French vessels *Talisman*, *Gabès*, *Guichen*, &c., 1882—1886.
Acquidah, Fort..............	4 45 15	2 2 10		
Dixcove, Fort	4 47 45	1 56 40		
Takoradi, ruined Fort	4 53 40	1 44 45		
Elmina, or St. George del Mina, Fort St. Iago......	5 5 0	1 20 25		
Cape Coast Castle, N.E. bastion	5 6 5	1 13 40	17 15	
Mauree, or Moree, Flagstaff	5 7 50	1 11 0		
Annamboe, Flagstaff	5 10 12	1 6 30		
Cormantine, Flagstaff......	5 11 30	1 4 45		
Tantumquerry, Extreme Point	5 12 50	0 47 30		
Mamkwadi or Devil's Hill, summit	5 19 20	0 39 30		*Longitude of Accra*, by four good chronometers of H.M.S. *Dryad*, Captain Hayes, 1832, 0° 15′ 20″ W., lat. 5° 32′ 27″ N.
Barracoe Point...............	5 23 0	0 28 30		
Accra, Fort James, West Bastion	5 31 48	0 11 30	16 50	
		EAST.		
Ningo, Fort Fredensborg	5 44 25	0 11 50		
Volta River, Dolben Point, West side of entrance ...	5 46 5	0 40 45		Captain Glover, 1870.
Cape St. Paul	5 49 50	0 58 30		
Quitta, Flagstaff	5 55 5	0 59 45		
Bagidah, West German Factory	6 9 30	1 22 28		
Porto Seguro, Fabre's Flagstaff.....................	6 13 0	1 32 28		

THE WEST COAST OF AFRICA.

	LAT. N.			LONG. E.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Little Popoe, Fabre's Flagstaff	6	13	30	1	35	55			Captains Vidal, Owen, Purchas, Kelly, Denham, and other and more recent observers, including the officers of the French vessels *Talisman*, *Gabés*, *Guichen*, &c., 1882—1886.
Grand Popoe, Fabre's Flagstaff	6	16	30	1	52	0			
Whydah, or Ajudah	6	20	10	2	4	50	16	5	
Kotonu or Appee, Pier [7]	6	21	30	2	26	25			
Porto Novo, Town	6	29	30	2	37	0			
Road	6	21	40	2	35	30			
Badagry, Mount	6	24	0	2	53	45			
Road	6	23	0	2	53	0			
Lagos River, Lighthouse	6	25	15	3	25	15			
Palma, Road	6	25	0	3	57	30			
Lekki, Road	6	23	0	4	8	30			
Benin River, N.W. point	5	46	1	5	2	45	15	40	Lieutenant Field, 1881.
Rio dos Esclavos, N. point	5	35	15	5	10	45			
River Forcados, Factory on South side	5	21	45	5	20	15			
River Dodo, North Point	4	53	15	5	26	25			
River Middleton, George Island, centre	4	32	0	5	39	20			
River Nun, Quorra, or Niger, the Bar	4	13	30	6	4	0	15	25	
Barracoon Point	4	19	16	6	3	12			Lieutenant Field, 1881.
Cape Nun	4	17	15	6	3	0			
Rio Bento or Brass River, West Point	4	17	0	6	12	0			
Harrison Factory	4	19	28	6	13	45			Lieutenant Field, 1881.
Rio St. Nicolas, or Third River, West Point	4	20	0	6	23	0			
New Calabar River, Foche Point	4	22	30	7	1	0			
Bonny River, Rough Corner Point	4	23	7	7	7	0	15	5	Lieutenant Field, 1881.
Observation Spot, 47 yards South of Boler's Pier [8]	4	25	56	7	9	50			Commander Pullen, 1891.
Opobo River, West Point	4	47	22	7	33	21			Lieutenant Field, 1881.
Old Calabar River, Tom Shot's Point, West side of the Entrance	4	34	30	8	19	30			H.M.S. *Growler*, 1869.
Backasey Gap, East of the Entrance	4	29	0	8	32	0			
Rio del Rey, West Point	4	30	0	8	44	30			
Bimbia Isle	3	57	30	9	17	0			
Cape Camaroons	3	55	0	9	30	0	14	45	
Camaroons Mountain, peak	4	13	30	9	11	30			
Rumby Mountains, highest peak	4	57	0	9	7	0			
Qua Mountain	5	13	30	8	53	0			
Malimba River, entrance	3	34	30	9	40	15			
Beundo River, Factory	3	13	0	9	58	0			
Batonga, English Factory	2	53	0	9	54	0			
Campo River, North Point	2	21	30	9	49	30			
San Bento River, Joho or South Point	1	35	0	9	39	0			

THE WEST COAST OF AFRICA.

	LAT.	LONG. E.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Cape St. John	North. 1 10 0	9 22 0		Captains Vidal, Owen, &c., &c.
Corisco Island, N.W. point	0 55 54	9 20 15	15 25	
Cape Esterias	0 38 30	9 21 15		
Point Clara or Joinville	0 31 0	9 21 0		
Gaboon River, Gombe or Round Corner Point, Lighthouse	0 18 30	9 19 30	15 30	
Libreville, Flagstaff	0 23 15	9 26 45		French Officers.
Cape Lopez	South. 0 36 0	8 43 0	16 0	
AFRICAN ISLANDS.				
FERNANDO PO	North.			Lieut. Badgley, Captain W. F. Owen, Comm. Boteler, and Spanish and Portuguese Surveys.
Clarence Peak	3 35 20	8 46 30		
Cape Bullen, Northern extremity	3 47 45	8 43 15		
Adelaide or Enrique Islet	3 46 0	8 47 17	15 0	
Santa Isabel, Point William or Fernanda, Lt.	3 46 0	8 47 42		
Cape Horatio, N.E. extremity	3 46 15	8 56 15		
Cape Vidal, East extr.	3 39 18	8 58 0		
Cape Barrow, South Rock	3 11 50	8 44 0		
Cape Eden, S.W. extr.	3 18 30	8 27 0		
Cape Badgley, West extr.	3 21 0	8 25 0		
Charles' Folly, N.W. extr.	3 28 15	8 29 40		
Cabras or Goat Isle, Lt.-house	3 32 25	8 34 40		
Boteler Rock	3 37 15	8 35 30		
PRINCES ISLAND				
San Antonio	1 38 25	7 25 15	15 40	
Ponta das Agulhas, or West Point, summit	1 35 30	7 20 25		
Carocha Island, or Dutchman's Cap	1 30 50	7 25 40		
South Brother Rock	1 21 10	7 17 30		
ST. THOMAS ISLAND				
Ilha das Cabras, Lighthouse	0 24 0	6 43 30	16 15	
ANNA DE CHAVES BAY, Observation Spot [8]	0 20 33	6 44 . 7		Commander Pullen, 1891.
Rolas Isle, S.W. Point	South. 0 1 0	6 31 40		
Ponta Furada	North. 0 14 0	6 28 0		
ANNO BOM ISLAND	South.			
Turtle Island	1 24 18	5 38 12	17 5	
Fernando Po Rock	1 23 36	5 36 42		

NOTES.

1. Cape Spartel.—The remarks of Mr. William Chapman, master of H.M.S. *Illustrious*, appeared to confirm the longitude of Tofiño, from whom he differs only 40 seconds in latitude, which he represents as so much more to the southward. The observations of Captain Smyth gave the lat. 35° 47′ 15″, and the long. 5° 55′ 45″, by chronometer and lunars. The coast, from Cape Spartel to Cape Bojador, was surveyed in the *Etna* and *Raven*, under Lieutenants Arlett and Kellett, 1835.

2. Empire of Marocco.—The points determined by Captain Washington we owe to an excellent Paper, entitled "*Geographical Notice of the Empire of Marocco;* by the late Lieutenant (afterwards Rear-Admiral) John Washington, R.N.," given in the first volume of the "*Journal of the Royal Geographical Society;*" a communication replete with interesting and useful information. Captain Washington afterwards became Hydrographer to the Navy.

3. City of Marocco.—The scientific traveller, *Don Juan Badia y Leblich*, commonly called *Ali Bey*, from his observations in 1803-4, gave the centre of Marocco as in lat. 31° 37′ N., long., long. 7° 35′ 30″ W. On reference to the Astronomical Journal of Captain Washington, there appear upwards of 100 sights for determining the longitude of the city. Distances between moon and sun; moon and stars East and West of her; and altitudes of the moon when in the prime vertical—the mean results of which give the longitude of a garden at the S.W. angle of the city as 7° 36′ W.; lat. 31° 37′ 20″, the mean of about 20 meridian altitudes of the sun.

4. Cape Geer, &c.—M. le Chevalier Jean Chas. de Borda was charged, in 1776, by Louis XVI., with a commission to the Canary Islands and the West Coast of Africa, for the express purpose of making observations, and determining the chief points of the Canary Islands, &c. He was furnished with time-keepers, by which he ascertained the positions, as they appeared in the earlier Charts and Tables. On this expedition, M. de Borda, in the ship *La Boussole*, was accompanied by the *Espiègle*, M. le Chastenet Puysegur, who afterwards composed the Pilot for St. Domingo; also by Captain Don Josef Varela, and another intelligent officer of the Spanish marine; all of whom assisted in the operations.

But in the years 1817-18, Captain (afterwards Baron) Roussin was employed by the French Government in surveying the coast between Cape Bojador, in 26° 7′ N.. and the Isle de Los, in 9½°; and this officer gave, most satisfactorily, many points not before ascertained.

Again, in 1820 and 1821, Captain William FitzWilliam Owen, in H.M.S. *Leven*, was commissioned by the English Admiralty to examine and settle the coast from Cape Noon southward; and his observations still further, and in a much more important degree, tended to perfect the hydrography of Western Africa. To Captain Owen's work, therefore, we refer most particularly in the Tables; and have only to add that there is a remarkable coincidence, in general, in the results of the two commanders; and that even in comparing either with those of M. de Borda, the differences, practically considered, are of little moment.

Most of the positions given in the Tables are as they appear on the most recent charts, though there still exists some amount of uncertainty as to the *exact* longitude of the various points on the West Coast of Africa, and in many parts even as to the latitude.

A survey of the Canary Islands, and the continental coast thence northward to Cape Spartel, was made by Lieutenants William Arlett and H. Kellett, commanders of the *Etna* and *Raven*, in 1835; the particulars of which are given in the "Journal of the Royal Geographical Society," vol. vi.

5. Sierra Leone, &c.—In preparing former editions of this work, we collected a large number of observations, which had been made, from time to time, on the coast of Guinea,

&c., between Sierra Leone and Cape Lopez; they included those previously given by the officers of H.M. ships *Argo*, *Amelia*, *Inconstant*, *Tartar*, and others, and we finally appended to such as we selected for the tabular statement the following remarks:—"Although we have paid the utmost attention in the comparison of different results, charts, and descriptions, as shown in the Tables and Notes, we are by no means satisfied with the conclusions as to many points eastward of Cape Palmas and St. Andrew's Bay. Indeed, all that has yet been done by the naval officers, and others, prove only the necessity of a new series, in order to establish so much as may be correct, and to rectify so much as may not be so." Happily, such rectification has taken place to a great extent, and many doubts, on the most important points, have recently vanished.

We give a specimen, on the longitude of Cape Sierra Leone. Many years ago, the late Sir George Young gave the longitude of this Cape as 12° 38′ 47; the French tables afterward, as 12° 54′; the Requisite Tables, 13° 9′ 17″; H.M.S. *Argo*, 1802, as 13° 12′; the *Inconstant*, 1816, the same; the *Amelia*, in 1812, 13° 17′ 30″; the *Leven* (Captain Owen), in 1826, 13° 18′ 0″; the *Eden* (Captain Owen), in 1827, 13° 18′ 10″; Captain Sabine, Royal Artillery, in 1822, 13° 19′ 0″; and Captain Purchas, in 1827, 13° 19′ 12″. Captain Owen's longitude, as given in the Table, appears to be correct. It may be added, that Lieut. Raper assumed the North Battery to be in 13° 14′ 30″, or nearly as in the Table.

By 318 lunar distances (23 sets), taken in the West Bastion of Fort Thornton, at Freetown, Captain Sabine, in 1822, made the longitude of that spot 13° 15′ 11″ W.; and in 1827, Captain Owen, in the *Eden*, made that of the Victualling Office 13° 14′ 30″. Latitude of the latter, 8° 30′ 6″; of Fort Thornton, by Captain Sabine, 8° 29′ 21″.

6. ASSINIE.—Observations made by the officers of the French vessel *Guichen*, in 1886, place the old Powder Mill in lat. 5° 4′ 45″ N., long. 3° 18′ 15″ W.

The COAST of GUINEA, between *Cape Three Points* and *Cape Lopez*, including the off-lying islands. Although this portion of the coast of Africa is described in the "Directory for the South Atlantic Ocean," we have considered it proper to continue the series of points in the Table. For the description of the coast, and remarks upon the positions, we refer the reader to the above work.

7. KOTONOU.—In 1890, Lieut. Serres, of the French Navy, determined the longitude telegraphically from Libreville, as $0^h\ 0^m\ 24{\cdot}86^s$ East of Paris, equivalent to 2° 26′ 30″ East of Greenwich.

8. BONNY AND ST. THOMAS ISLAND.—These positions were accurately determined by means of telegraphic signals with the Cape of Good Hope Observatory, by Commander Pullen, R.N., in 1891.

The VARIATION of the COMPASS is *decreasing* on the West Coast of Africa, at the rate of 3′ to 4′ per annum.

9. THE AZORES, OR WESTERN ISLANDS.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Formigas or Ants:									
Formigao or Hormigon, highest rock, 35 feet	37	16	30	24	47	0	22	40	The Survey made by Capt. A. T. E. Vidal, 1842.
Dollabarats Shoal, 11 ft.	37	14	0	24	43	55			
Santa Maria or St. Mary:									
Ponta do Castello, or S.E. Point	36	55	30	25	1	30			
Villa do Porto, Quay ...	36	56	30	25	9	30	22	40	
Maldebarca Rock, off the N.W. Point	36	59	25	25	11	50			
Ponta dos Matos	37	0	45	25	4	30			
San Miguel or St. Michael's:									
Ferraria or West Point	37	51	45	25	52	10	23	15	
Ponta Delgada, Castle...	37	43	55	25	41	0	23	10	
Villa Franca, Island......	37	42	10	25	27	0			
Pta. Retorta, S.W. Point	37	44	25	25	10	30			
Arnel Point, Lighthouse	37	49	25	25	8	30	23	0	
Ponta da Ajuda............	37	51	50	25	19	20			
Morro da Ribeira Grande	37	50	32	25	29	45			
Porto Capellas, Morro...	37	50	30	25	41	45			
Ponta de Bretanha	37	54	30	25	47	35			
Terceira:									
Monte do Brasil, near Angra, South edge ...	38	38	0	27	14	10	23	55	
Praya, Ponta de Malmarenda	38	44	0	27	3	0			
Pta. de Serrata or W. Pt.	38	45	45	27	23	30			
St. George:									
Topo Island, off S.E. Pt.	38	33	6	27	46	0	24	0	
Ponta de Rosales, or N.W. Point	38	45	5	28	19	15			
Graciosa:									
Fort at Praya	39	3	5	27	58	46	24	20	
Ponta de Fozo do Porto, or West Point	39	4	10	28	4	40			
Pico:									
The summit of the peak	38	27	30	28	24	30			
Pta. da Ilha, or E. Point	38	24	30	28	2	15	24	0	
Magdalena Rocks, off W. Point, North Rock ...	38	32	9	28	33	32			
Fayal:									
Horta, Santa Cruz Castle	38	31	45	28	38	24			
The S.E. point, or Morro da N. S. da Guia	38	31	20	28	38	5	24	10	
Caldeira, sum., 3,351 ft.	38	34	30	28	43	30			
Ponta da Negra, W. Pt.	38	36	0	28	50	15			
Flores:									
Santa Cruz, Fort	39	27	3	31	8	15	24	50	
Corvo:									
South Point, or Ponta do Pesqueiro-alto	39	40	7	31	8	0	25	0	

NOTES.

The positions here given accord with those on the latest charts, but it is possible the longitudes may be somewhat in error, and this will be decided when the telegraph cable has been established. M. Fleurieu ascertained the position of the Mount of Brasil, near Angra, in Terceira, to be lat. 38° 38′ 37″ N., long. 27° 12′ 27″ W. Tofiño's result was lat. 38° 38′ 10″, long. 27° 14′ 40″, a remarkable coincidence, considering the distance of time at which the observations were made. The longitude of this spot was, therefore, assumed by the Spanish commander, as the meridian referred to for the points subsequently determined. The summit of the Mount, as given by Captain FitzRoy, R.N., is in lat. 38° 38′ 35″, long. 27° 12′ 54″.

Captain Alexander T. E. Vidal, R.N., who re-surveyed these islands, placed the Fort at Villa do Porto, in St. Mary's, in lat. 36° 56′ 30″, long. 25° 9′ 45″ W.

The VARIATION of the COMPASS is *decreasing* among the Azores, at the rate of about 2¼′ per annum.

10. MADEIRA AND THE CANARY ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
MADEIRA.	° ′ ″	° ′ ″	° ′	
FUNCHAL, Flagstaff of Fort St. Jago ....[1]	32 38 4	16 53 58	18 50	Captain Matthew Flinders, H.M.S. *Investigator*; General Sir Thomas Brisbane; Capt. W. F. Owen; Capt. Vidal; and U. S. Officers, 1878-9.
Camera de Lobos............	32 38 25	16 58 50		
Ponta do Pargo, the West Point, Semaphore	32 48 7	17 16 0		
Tristao, or N.W. Point ...	32 51 25	17 12 0		
San Jorge or North Point	32 49 45	16 54 25		
Ponta de San Lourenzo, Lighthouse..................	32 43 10	16 39 0		
Cape Garajao, or Brazen Head, S.E. extremity ...	32 37 30	16 51 0		
Pico Ruivo, summit, 6,056 feet	32 45 0	16 56 30		
Porto Santo:				
Villa Baleira on the South side	33 3 30	16 19 45	18 40	Captain A. T. E. Vidal.
Baixo Island, S. Point...	32 59 40	16 22 35		
North-East Rock, 330 ft.	33 7 40	16 15 45		
Dezertas:				
Chao Island, Sail Rock	32 34 50	16 32 10		
Dezerta Grande, summit, 1,600 ft.	32 31 15	16 30 25		
Bugio Island, Agulha or South Point	32 23 15	16 27 10		
The Salvages:				
Great Salvage, Burt Peak, on West side ...	30 7 31	15 54 20	18 25	
Great Piton Islet, South Point	30 0 0	16 4 0		

THE CANARY ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
CANARY ISLANDS.	° ′ ″	° ′ ″	° ′	
Lanzarote:				
Allegranza Isle, Lt.-ho.	29 23 15	13 29 30	18 0	The Spanish Government Surveys, &c.
Port de Naos, Lightho.	28 57 20	13 32 30		
Cape Pechiguera, Lt.-ho.	28 50 45	13 52 30		
Fuerteventura:				
Isle of Lobos, Point Martino, Lighthouse	28 45 25	13 49 0		
Point Jandia, the S.W. Point, Lighthouse ...	28 2 40	14 31 0		
Canaria, or Grand Canary:				
The Isleta, or N.E. Point, Lighthouse...............	28 11 0	15 25 30	18 25	
Point Maspalomas, or S. Point, Lighthouse ...	27 44 0	15 35 0		
Cape Sardina, Lightho.	28 9 0	15 43 0		
Tenerife:				
Santa Cruz, Mole Lt. [2]	28 28 33	16 14 56		
Pico de Teide, summit...	28 16 35	16 38 30		
Orotava, N.W. side	28 23 30	16 31 30	18 45	
Punta de Anaga, East Point, Lighthouse......	28 35 15	16 8 0		
Punta de la Rasca, South Point	28 0 30	16 43 0		
Gomera:				
The Port.....................	28 5 30	17 6 30		
Pta. de Calera, W. Point	28 6 45	17 21 30		
Palma:				
Sta. Cruz, on the E. side	28 40 30	17 45 0	19 5	
Taxacorte, on the W. side	28 38 12	17 55 55		
Cumplida Point, Lt.-ho.	28 50 30	17 46 20		
Fuencaliente, or South Point	28 26 30	17 50 15		
Hierro or Ferro:				
Port de Hierro	27 46 30	17 54 22	19 0	
Point Orchilla, S.W. Pt.	27 41 40	18 9 45		
Pta. de la Restinga, S. Pt.	27 37 30	17 59 30		

NOTES.

1. Funchal.—The latitude of Funchal is well ascertained, though from the isolated position of the island there have been some differences in the longitude as given by various observers. The longitude was estimated by M. Bory, in 1772, as 16° 56′. Our respected countryman, Captain Flinders, from observations in H.M.S. *Investigator*, 1801, made the latitude of the road to be 32° 37′ 44″, and the greatest longitude, by any of six chronometers, 16° 54′ 26″.

Sir Thomas Brisbane, on his voyage to New South Wales (1821), obtained his time at the house of Mr. J. W. Gordon, at Funchal, by four excellent chronometers, by which the mean longitude was concluded as 16° 54′ 36″. At the same time the latitude of the tower, on Mr. Gordon's house, was found to be 32° 38′ 19·7″, and that of Loo Rock, 32° 37′ 53·8″. The longitude given by Sir Thomas Brisbane was confirmed by ten Admiralty chronometers, under the care of Dr. Tiarks, in 1823, which gave for the longitude of the British Consul's Garden, 16° 54′ 45″ (in time, 1h 7m 39s); the latitude is 32° 38′ 22″ N. Captain Fitzwilliam Owen, from observations in H.M.S. *Leven*, 1820, gave the landing-place, near the Loo Castle, in lat. 32° 37′ 42″ N., long. 16° 55′ 30″ W.

By telegraphic determinations from Lisbon, made in 1878 and 1879 by United States officers, in connection with establishing secondary meridians for the East Coast of South America, the longitude of the flagstaff of Fort St. Jago was ascertained to be 16° 53′ 53·4″ W.; the latitude is given as 32° 38′ 4·08″ W. This would place the British Consul's House in longitude 16° 54′ 30″ W., very nearly the position ascertained by Dr. Tiarks.

2. Teneriffe.—The position of Santa Cruz in the Table is that given by Captain Vidal on his completion of the survey of these islands (1844), and is apparently correct. Previous observations placed the longitude generally one or two minutes more to the westward of those in the Table.

Captain Fitzwilliam Owen, from his observations in the *Leven*, 1820, made the Mole Head in lat. 28° 27′ 54″ N., long. 16° 15′ 0″ W. The peak in lat. 28° 16′ 24″ N., long. 16° 39′ W.

The Variation of the Compass is *decreasing* at Madeira and the Canary Islands, at the rate of about 3′ per annum.

11. CAPE VERDE ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Sal or Salt Island:				
North Point	16 51 0	22 55 0	20 15	The Survey by Lieutenants (afterwards Captains) Vidal and Mudge, R.N., 1819—1821, compared with the observations of Captains King, Foster, Owen, &c., &c.
South Point	16 34 15	22 56 30		
Lion's Head, summit	16 41 35	22 59 40		
Bonavista:				
Sol or N.W. Point	16 13 10	22 56 30		
Pontinha or N.E. Point	16 11 45	22 44 0	20 5	
English Road, Lightho. on Small Island	16 9 10	22 57 15		
Curral Velho or South Point	15 57 0	22 49 10		
Leton Rock	15 48 0	23 9 5		
Mayo, or Isle of May:				
North Point	15 19 0	23 12 5		
English Road, Light on Fort	15 7 30	23 13 20		
South Point	15 6 40	23 10 15		

CAPE VERDE ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Island of St. Iago:				
Bighude, or North Point	15 19 30	23 45 45	19 55	The Survey by Lieutenants (afterwards Captains) Vidal and Mudge, R.N., 1819—1821, compared with the observations of Captains King, Foster, Owen, &c., &c.
East Point, Porto do Lobo, Lighthouse......	14 59 30	23 25 15		
Porto Praya, Quail Id. [1]	14 53 40	23 30 34		
S.W. Point	14 53 30	23 43 40		
Island of Fogo:				
North Point	15 1 20	24 21 30		
Town of N. S. da Luz, Lt. near Fort Carlotta	14 52 15	24 31 0	19 45	
Brava:				
Jalunga or East Point, Light	14 50 30	24 40 10		
South Point	14 46 0	24 42 40		
East Rombo Islet, N. end	14 55 45	24 40 30		
St. Nicholas:				
East Point..................	16 34 30	23 59 30	20 0	
North Point	16 41 45	24 20 40		
West Point, Lighthouse	16 37 45	24 26 20		
South Point	16 28 20	24 18 15		
Rolla Road, Flagstaff near Preguiza Fort ...	16 34 30	24 16 0		
Raza, Landing Place on West side	16 38 0	24 37 0		
Branca, North Point	16 41 0	24 41 30		
St. Lucia:				
East Point..................	16 46 0	24 41 45		
North Point	16 49 0	24 47 10		
St. Vincent:				
PORTO GRANDE, Flagstaff at Telegraph Office.................. [2]	16 53 20	24 59 22	19 55	U. S. Officers, 1878-9.
Bird Island, Lt.-ho.	16 54 45	25 1 10		
West Point..................	16 50 0	25 5 30		
East Point..................	16 52 0	24 52 30		
St. Antonio: [3]				
Punta do Sol or North Point, Lighthouse ...	17 12 15	25 5 45	19 55	
West Point	17 4 0	25 22 10		
South Point	16 55 0	25 18 40		
East Point, Bull Point, Lighthouse...............	17 6 50	24 59 20		

NOTES.

1. Porto Praya.—The longitude of this place appears to be well determined, particular attention having been directed to it by many of our most skilful navigators. Captain FitzRoy placed the West point or landing-place on Quail Island (called also Gun Point), at Porto Praya, in longitude 23° 30′ 0″ W. Captain P. P. King made it 23° 30′ 17″; Captain Vidal, 23° 31′ 28″; and Captain Owen, 23° 31′ 8″; therefore, 23° 30′ 34″, the longitude formerly assigned to it by Mr. Purdy, in previous editions of this work, cannot be far from the truth. Telegraphic observations by MM. de Sugny and Garnier, 1885, place the flagstaff on Quail Island as 6° 4′ 49·6″ West of Dakar East jetty, which would make it 23° 30′ 17″ West of Greenwich.

2. St. Vincent.—The position of the flagstaff in front of the Brasilian Submarine Telegraph Company's Office was determined, by telegraphic means, by United States officers, in 1878 and 1879, in connection with the establishment of secondary meridians on the East Coast of South America, to be in long. 24° 59′ 22·8″ W., or about 1′ 50″ eastward of the position previously given. The latitude is 16° 53′ 20·12″ N.

3. Captain King made Terrafal Bay, at the S.W. end, by eleven chronometers, in longitude 25° 20′ 1″; Captain Owen made it 25° 21′ 42″; and Captain Foster, 25° 22′ 56″, the mean from these being about 25° 21′ 30″; and the West point, 25° 23′ 10″.

The Variation of the Compass is *increasing* among the Cape Verde Islands, at the rate of about 1′ per annum.

12. THE FÆROE ISLES, ICELAND, GREENLAND, LABRADOR, AND NEWFOUNDLAND.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
The FÆROE ISLANDS.				
Munken Islet	61 23 40	6 46 0	24 0	The Survey by Capt. Born, of the Danish Navy, 1790-5, corrected by later observers.
Suderö, Porkerji	61 42 0	6 50 0		
Sandö, Village of Sand ...	61 52 30	6 50 0		
Waagö, Sorwaag	62 6 30	7 15 0		
Myggenæs, West point ...	62 8 0	7 36 0		
Stromö, Thorshavn	62 2 40	6 46 0	24 30	
Osterö, Ristang or N. Point	62 22 0	6 56 0		
Fuglö, East point............	62 20 30	6 18 0		
ICELAND.				
Snefells Jokel, 4,696 feet	64 48 0	23 48 0	40 40	Mr. Bjorn Gunnlaugsson's Survey, 1849, the French Survey, 1859, &c.
Breidavik, Stapi	64 46 15	23 35 0		
Akra Nes	64 39 40	22 25 0		
Thormod's Skar, S. point	64 25 30	22 17 30		
Reikiavik, Hill to N.W. ...	64 8 38	21 54 58	38 20	
Cape Utskalar, Beacon ...	64 4 50	22 40 45		

ICELAND AND GREENLAND.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Reykjanes Point, Lightho.	63	48	30	22	41	50			Mr. Bjorn Gunnlaugsson's Survey, 1849, the French Survey, 1859, &c.
Geirfuglasker	63	43	0	23	5	0			
Grindavik Church	63	49	0	22	30	0			
Herdisarvik, anchorage	63	51	30	21	46	15			
Keflavik, anchorage	63	50	30	21	26	30			
Olfusa, entrance	63	52	0	21	10	15			
Piorsa, entrance	63	46	40	20	48	15			
Affall, entrance	63	37	45	20	30	30			
Markarfliot, entrance	63	31	30	20	0	0			
Mount Hekla, 5,364 feet	63	59	0	19	39	0			
Portland Head, the South point of Iceland	63	23	45	19	6	30	35	40	
Ingolfs Höfde	63	48	50	16	35	0			
Horne Fiord, entrance	64	15	0	15	8	30			
Hvalsbak Islet	64	40	0	13	12	0			
Rode Fiord, Krosnæs	65	1	30	13	32	50			
Hornnæs, East point of Iceland	65	10	50	13	28	0	32	10	
Langanæs, N.E. point	66	23	0	14	28	0			
Revsnæs, North point of Iceland	66	33	30	16	8	0			
Tiornæs	66	13	40	17	7	0			
Grimsey Church	66	33	30	18	0	0			
Holar Church	65	45	30	19	5	0			
Skagen, Skagataa	66	8	0	20	3	30			
North Cape	66	29	0	22	25	30	40	25	
Staalbierg Huk, W. point	65	30	25	24	30	15			
GREENLAND.									
Land reported, 1870 ... [1]	73	33	0	19	0	0	46	0	North German Polar Expedition, 1870.
Cape Bismarck	76	47	30	18	30	0			
Pendulum Island, 3,000 ft.	74	39	0	18	31	30			
Cape Hold-with-Hope, 3,000 feet	73	30	0	20	32	30	45	0	The DANISH GOVERNMENT CHARTS.
K. Francis Joseph Fiord, entrance, C. Humboldt	73	10	30	22	27	30			
Davy Sound, Smith Island	71	49	0	22	15	0			
Cape Gladstone	71	33	0	21	40	0			
Scoresby Sound, Cape Brewster	70	11	0	21	59	0	48	30	
Knighton Inlet, C. Barclay	69	14	0	24	25	0			
Cape Grivel	68	34	0	25	38	0			
Horror Bay, entrance	66	49	0	34	5	0	50	50	
Cape Dan [2]	65	31	0	37	0	0			The CHART of GREENLAND, published by authority at Copenhagen in 1832, to illustrate the voyage of Captain Graah, corrected by later explorers.
Dannebrogs Oe, summit	65	19	0	39	34	0			
Cape Löwenorn	64	30	0	40	7	30			
Colberger Heide	64	4	0	40	35	0			
Cape Mosting	63	40	0	40	33	0			
Cape Juel	63	13	0	41	5	0			
Cape Bille	62	0	30	42	3	0	51	30	
Cape Tordenskiold	61	25	0	42	20	0			
Cape Discord	60	53	0	42	36	0			

GREENLAND AND LABRADOR.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Cape Valloe	60	35	0	42	50	0			Danish Charts, &c.
Cape Farewell or Statenhuk	59	46	0	43	52	30	47	5	
Frederiksdalor, Ikigeit	60	0	0	44	43	0			
Arsuk Fiord, Ivugtut	61	13	0	48	7	30	50	35	
Frederikshaab	62	0	0	49	42	0			
Godthaab	64	11	0	51	42	30			
Hamborgerland, West end	65	34	0	53	10	0			
Holsteinborg, Flagstaff	66	55	42	53	42	0			
Disko Bay, Egedesminde	68	42	0	52	45	0			
Christianshaab	68	48	0	51	6	0	65	0	
Jakobshavn	69	12	30	51	2	0			
Godhavn	69	14	0	53	28	0			
Disko Island, East side, coal cliffs	70	0	0	52	50	0			
Hare Island (coal), N. point	70	28	0	54	56	0			
Svartenhuk	71	41	0	55	50	0			
Upernivik	72	47	0	56	7	30			
Horse Head	73	38	0	57	1	0			
Red Head	75	0	0	57	15	0			
Carey Islands, southern	76	40	0	72	28	0			
Hall's Rest, Tablet erected by British, 1876	81	38	0	61	40	0	100	0	
Alert, Winter Q., 1875-6	82	27	0	61	20	0			*Alert* and *Discovery*, 1875-6.
Markham & Parr's farthest	83	20	26	63	0	0			
Cape Colombia (Aldrich)	83	7	45	70	30	0			
Aldrich's farthest	82	21	0	86	0	0			
Beaumont's farthest	82	20	0	51	0	0			
LABRADOR [8].									
Cape Walsingham	66	0	0	61	1	0			Various Surveys.
Resolution Island, C. Best	61	21	0	65	0	0	52	0	
Cape Chidley	60	29	0	64	21	0			
Eclipse Harbour, Mount Bache, 2,150 feet	59	51	17	64	5	15			
Ramah Mission Station	58	55	0	63	28	0			
Hebron Mission Station, anchorage	58	17	0	62	38	0	46	30	
Akkak Mission Station	57	40	0	61	55	0			
Port Manvers, entrance	57	0	0	61	17	0			
Nain Church	56	32	45	61	40	30			Staff-Commanders Maxwell
Ford Harbour, Head	56	26	59	61	18	11			and Chimmo, 1867—1875.
Farmyard Isles	55	49	30	58	52	0			
Hopedale Mission Station	55	27	4	60	11	49			
Gull Island, North end	55	30	20	59	42	30			
Cape Mokkovik	55	13	50	59	8	20	41	0	
Aillik Bay, H. B. Co. Sta.	55	9	0	59	5	0			
Webeck Har., (Cannatocktuit), Harbour Rocks	54	54	27	58	1	51			
Cape Harrison	54	55	50	57	55	40			
Bulldog Island	54	45	10	56	50	0			
White Bear Ids., E. rock	54	27	0	56	50	35			

LABRADOR AND NEWFOUNDLAND.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Hamilton Inlet, Rigoulette	54 11 20	58 25 10		Staff-Commanders Maxwell and Chimmo.
Herring Isles, S.E. extr.	54 19 20	57 5 0		
Outer Gannet Island	54 0 0	56 32 0	39 30	
Independent Island, S. pt.	53 50 40	56 52 30		
The Wolves, S.E. rock ...	53 48 25	56 18 45		
Curlew Harb., Curlew Id.	53 46 0	56 33 25		
Cartwright Harb., Castle	53 42 37	56 59 50		
South Wolf Island, South Wolf Rock.................	53 58 55	55 53 0		
Domino Run, Spotted Id., S.E. point	53 29 30	55 43 10		
Grog Island, summit ...	53 30 36	55 52 30		
Roundhill Island, S.E. end	53 25 50	55 35 45		
Shoal Bay, E. entrance pt.	53 16 20	55 46 10		
American Tickle, Long Id.	53 12 50	55 41 29		
Partridge Island, East end	53 10 30	55 42 30		
Boulter Rock	53 6 15	54 45 38		
Venison Tickle, Flagstaff...	52 58 9	55 45 55		
Cape Bluff	52 50 15	55 48 0		
St. Michael Bay, First Pt.	52 42 0	55 48 30		
Occasional Harbour, Twin Islands	52 40 0	55 44 18	37 20	
Fishing Ship Harbour, Entrance Island	52 36 10	55 45 20		
Cape St. Francis	52 33 30	55 41 30		
St. Lewis Sound, Goose Id,	52 19 17	55 42 50		
Islet Bay, anchorage	52 13 0	55 42 0		The Surveys by Admiral Bayfield, 1827—1860.
Peterel Island, S.E. end...	52 4 0	55 41 0		
Chateau Bay, York Point	51 58 0	55 52 50		
Barge Bay	51 48 20	56 11 0		
Amour Point, Lighthouse	51 27 40	56 51 0	34 55	
NEWFOUNDLAND [4].				
Belle Isle, N.E. point	52 1 0	55 15 20	36 25	The Surveys by Lieutenant (later Admiral) Frederick Bullock, R.N., and his assistants, Messrs. T. Smith, &c., 1823, 1824, 1825, and 1826. The longitudes adjusted by the observations of Capt. H. W. Bayfield, &c., &c.
Lighthouse on South Pt.	51 53 0	55 22 15		
Cape Norman, Lighthouse	51 38 0	55 53 40		
Cape Bauld	51 38 50	55 25 0	35 45	
Griguet Bay, Camel Island, East point	51 32 38	55 26 20		
White Cape, near St. Lunaire Bay	51 30 50	55 26 20		
Bréhat or Braha Shoal ...	51 26 5	55 25 30		
Cape St. Anthony	51 21 40	55 30 30		
Crémaillière Cove, entr. ...	51 20 0	55 35 0		
Goose Cape, S.E. point ...	51 18 30	55 35 0		
How Harbour, entrance, West point..................	51 20 30	55 55 20		
Fishot Isles, Northern Isle	51 13 20	55 40 20		
Croc Harbour, South point	51 2 30	55 47 10		
Groais Isle, N.E. point ...	50 58 20	55 32 30	34 40	
Bell Island, N.E. Rock ...	50 48 45	55 26 50		
Rouge Islet, North point	50 54 10	55 46 30		

NEWFOUNDLAND.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Canada Bay, Canada Head	50	41	50	56	6	0			The Surveys by Lieutenant Bullock, R.N., &c.
Hooping Harbour, entrance	50	36	30	56	12	0			
Fourchette Harbour, entr.	50	32	0	56	15	40			
Orange Bay, entrance......	50	23	30	56	25	30			
Little Harbour, Deep Head	50	15	0	56	30	20			
Cat Head, extremity	50	8	10	56	33	0			
Coney Arm Head...........	49	57	50	55	43	30			
River Head	49	32	45	56	50	0			
Partridge Point	50	10	0	56	7	50			
Fleur de Lys Harbour, Bear Hill	50	7	40	56	6	0			
St. Barbe, or Horse Isles, S.E. point	50	11	30	55	41	50	33	30	
Paquet Harbour, entrance	49	58	45	55	50	40			
La Scie Harbour, N. point	49	58	30	55	35	50			
Cape St. John :									
North Bill	50	0	20	55	30	0			
South Bill	49	58	15	55	28	10			
St. John's Gull Isle, summit	49	59	50	55	21	30			
Bishop Rock	49	56	18	55	26	30	33	15	
Betts Cove, head	49	49	10	55	47	10			
Nippers Isles, S.E. point	49	46	50	55	49	55			
Cutwell Harbour, E. point	49	36	40	55	40	0			
League Rocks, E. extreme	49	34	30	55	29	45			
Triton Harbour, entrance	49	32	30	55	36	20			
Fortune Harbour, N.W. pt.	49	32	30	55	14	0			
Toulinguet Island, Lt.-ho.	49	41	25	54	47	30			
Change Isles, North End Islet	49	40	50	54	25	40			
Fogo Isles, Change Island Tickles, Tobacco Id....	49	41	0	54	28	5			The Surveys by Staff-Commander J. H. Kerr, R.N., 1866—1871; Capt. Orlebar, R.N., 1862—1864; &c.
Fogo Harb., Slade's staff	49	43	0	54	16	50			
Hare Bay, N.E. islet off West entrance point...	49	41	0	54	17	20			
Seldom-come-by Harbour, Ship Hill	49	36	50	54	11	57			
Ireland Rocks, East end...	49	51	30	54	1	30			
Snap Rock....................	49	53	15	53	42	30			
Funk Island, West end ...	49	45	35	53	11	10	33	45	
Offer Wadham Island, Lt.	49	35	35	53	45	15			
Gander Island, North point	49	28	20	54	22	30			
Deadman Point...............	49	21	20	53	40	0			
Cape Freels, Brandies Islet	49	16	30	53	27	40	32	55	
Stinking Islets, East islet	49	10	15	53	20	40			
Puffin Island, Light.........	49	3	40	53	32	30			
Offer Gooseberry Island, North end	48	56	35	53	31	40			
Salvage Bay, Cow Head...	48	42	0	53	38	40			
Barrow Har., Gerrard Hill	48	40	48	53	39	14			
Cape Bonavista, Light ...	48	41	58	53	4	35	32	20	
Kelp Rock, breaks	48	47	50	53	4	0			
Catalina Harbour, Green Island Lighthouse	48	30	15	53	2	40			
Horse Chops.................	48	20	50	53	12	25			

NEWFOUNDLAND.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Trinity Harb., Fort Point Lighthouse	48	22	0	53	20	50			The Surveys by Staff-Commander J. H. Kerr, R.N., Captain Orlebar, R.N., and other Officers.
Bonaventure Head	48	16	50	53	23	20			
Trinity Bay, East Random Head	48	5	50	53	33	0			
Deer Harbour, Green Id.	47	53	43	53	42	25			
Tickle Point	47	42	10	53	42	10			
Heart's Content Church	47	52	35	53	22	14			
New Perlican Church	47	54	45	53	21	40			
Salvage Point	48	3	55	53	9	0			
Grates Point	48	10	15	52	56	30			
Baccalieu Island, Lightho.	48	8	50	52	47	50	31	40	
Conception Bay, Harbour Grace Island, Lightho.	47	42	45	53	8	11			
Bay Roberts, East entrance point	47	36	45	53	10	10			
Cape St. Francis, Lt.-ho.	47	48	30	52	47	10	31	10	
Black Head	47	45	40	52	42	40			
Torbay Point	47	39	45	52	39	45			
St. John's Harbour:									
CHAIN ROCK BATTERY [4]	47	34	2	52	40	47	31	0	
Fort Amherst Light, South side of entrance	47	33	50	52	40	30			
Cape Spear, Lighthouse	47	31	15	52	37	12			
Bull Head	47	18	25	52	44	45			
Cape Broyle, North Point	47	4	25	52	50	50			Captain James Cook, Captain (Rear-Admiral) H. W. Bayfield, 1827 to 1860, Captain Orlebar, 1862, and Staff-Commander Maxwell, 1873—1876.
Cape Ballard	46	47	10	52	56	50			
Cape Race, Lighthouse	46	39	25	53	4	20	29	30	
Virgin Rocks, on the Great Bank of Newfoundland	46	26	30	50	57	30			
Trepassey Harbour, Shingle Neck	46	43	32	53	22	13			
Cape Pine, Lighthouse	46	37	4	53	31	45			
Cape St. Mary, Lighthouse	46	49	30	54	11	30			
Placentia Harbour, Prive-cœur Point	47	15	24	53	59	30	30	10	
Cooper Cove, Obs. Spot	47	17	55	53	58	35			
Fox Island, S.W. point	47	21	10	53	59	10			
Burin Island, Lighthouse	47	0	26	55	8	48			
Corbin Head	46	56	20	55	18	40			
Great St. Lawrence Harbour, Episcopal Church	46	55	26	55	22	58			
Pointe aux Gauls	46	50	40	55	44	40			
St. Pierre Island, Galantry Head Lighthouse	46	45	40	56	9	32	28	30	
Pigeon Island, North pt.	46	49	10	56	10	30			
Green Island, West point	46	52	30	56	5	38			
Miquelon Islands, Cape Coupé, South point	46	46	39	56	21	0			
Miquelon Road, anchorage	47	6	0	56	22	0			
Cape Miquelon, North pt.	47	8	30	56	20	50			
Brunet Island, Lighthouse	47	15	30	55	53	10			
Belloram, Light	47	31	30	55	25	0			

NEWFOUNDLAND.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Pass Island, Lighthouse...	47 29 30	56 11 10		Captain James Cook, Captain (Rear-Admiral) H. W. Bayfield, Capt. Orlebar, and Staff-Commander Maxwell.
Devil Bay, E. entrance pt.	47 36 40	56 37 10		
New Harbour, entrance ...	47 35 30	56 39 10	29 30	
Fransway or François Bay, West entrance point ...	47 33 30	56 44 0		
Cape La Hune	47 31 30	56 51 50		
Little River Point	47 34 5	57 7 15		
Old Man's Bay, East point	47 35 35	57 10 50		
Ramea Ids., Ramea Harb., North entrance point ...	47 30 30	57 24 30		
Bear Island, West point...	47 36 35	57 28 35		
Burgeo Ids., Boar Island, Lighthouse	47 36 10	57 35 10		
La Poile Bay, Great Harbour, Episcopal Church	47 39 48	58 24 18		
Rose Blanche Point, Lt.-ho.	47 35 50	58 41 30		
Port Basque, Channel Ch.	47 33 56	59 7 33		
Cape Ray, Lighthouse [5]	47 37 0	59 18 0	28 15	
Codroy Roads, Beach Point	47 52 38	59 23 47		
St. George Har., Sandy Pt.	48 27 27	58 30 31		
Cape St. George	48 28 25	59 15 20		
Bay of Islands, South Head	49 9 0	58 22 10		
Cape Gregory	49 22 20	58 14 20	31 15	
Bonne Bay, S. entrance pt.	49 33 30	58 0 0		
Cow Head	49 55 0	57 49 50		
Rich Point, Lighthouse ...	50 41 55	57 24 30		
St. John Harbour, South entrance point	50 48 0	57 15 30		
Ferolle Point, S.W. extr.	51 0 40	57 6 20		
Sainte Genevieve Bay, Entrance Island...............	51 8 0	56 49 36		
Green Island, centre	51 24 0	56 33 30		
Cape Norman, Lighthouse	51 38 0	55 53 40	35 30	

NOTES.

1. The North German Polar Expedition of 1870, consisted of the steam-ship *Germania*, 143 tons, and the *Hansa*, a sailing vessel of 242 tons. Its object was geographical discovery towards the North Pole by the Eastern Coast of Greenland. On reaching the coast, the vessels became separated, the sailing ship, proceeding to the southward, was ultimately lost in a storm, and the crew, taking refuge on an ice-floe, were drifted several hundred miles to the southward, to within reach of a Danish settlement near the southern extremity of Greenland. The *Germania* wintered near the southern end of Pendulum Island, near the locality of Sir Edward Sabine's Magnetic Observatory, when he visited the locality with Captain Clavering, in 1823. From this point, sledging expeditions in the spring of 1870 were undertaken, which reached as far as 77° North latitude.

2. An interesting account was published of the *Discoveries on the Eastern Coast of Greenland*, by Captain Graah, of the Danish Royal Navy, in 1829, who proceeded along the coast from Staten Hook, to the parallel of 65½°, and disproved the existence of any ancient European colony upon it. In a single boat, amid difficulties almost insuperable,

with only two Greenland men and four women, M. Graah reached an island, in latitude 65° 18°, longitude, *computed*, 38° 27′; he proceeded onward until stopped by an insurmountable barrier of ice, and was forced to return to the S.W.

All the coast appeared to be colder, more barren, and miserable, than the western coast. "It may be said to consist of one uninterrupted glacier, exhibiting only a few patches of vegetation, generally on the banks of the rivers, and elsewhere, often advancing into the sea, and forming promontories of ice, which are passed with so much the more danger that they frequently fall in avalanches." During the whole summer of 1829 there was not one day which could be called warm; and, before the 14th of June, the thermometer had never risen above 53°.

During his last stay, in 1831, Capt. Graah determined the longitudes of the two southern Danish settlements, *Julianeshaab* and *Nennortalic*, with great precision, by means of occultations of fixed stars, &c.; and we also gained, by his observations, the positions of *Cape Farewell*, never before ascertained, and *Cape Christian*, another promontory of the same island.

The Eastern Coast is distinguished by the name of the late excellent *King Frederick VI.*

3. Labrador.—The Eastern Coast of Labrador was surveyed by the Newfoundland survey party under Commanders Chimmo and Maxwell. It was an arduous undertaking, on account of the shortness of the navigable season.

4. Newfoundland.—The work of the surveyors in recent years has placed the coast of the island in a much more satisfactory light to the navigator. Previously, great errors existed. The assigned positions of Cape Bonavista is an evidence of the uncertainty which existed in the longitudes of the old surveys. The first sheet of the survey by Messrs. Holbrook and Bullock, in 1817, made the long. 52° 59′ 15″. In the re-issue, shortly afterwards, of the same sheet, it was shifted to long. 53° 8′ 20″, or 9° 5′ farther West. In the modern survey it is placed in 53° 4′ 35″.

The coasts to the northward appear to have been given much more to the *westward*. It is necessary to notice these discrepancies here, although the amounts of differences, as now settled, are not important to the general navigator.

The exact longitude was determined by the Electric Telegraph connecting Ireland with Heart's Content in Trinity Bay in 1867, and from this the principal meridian has been deduced. The Admiralty Survey takes the Chain Rock Battery, on the North side of the entrance of St. John's Harbour, as the meridian.

5. The West Coast of Newfoundland is still represented according to the surveys of the circumnavigator, Captain James Cook, and Michael Lane, at the latter part of the eighteenth century. The original charts of the West and South Coasts were published by Mr. Laurie's predecessors, and it will be seen, upon comparison, that the positions given in Cook's first work are still found to be near the truth.

The Variation of the Compass is *decreasing* on the Coasts of Iceland, at the rate of about 5½′ per annum. It is nearly *stationary* on the Coasts of Newfoundland and Labrador.

13. THE GULF AND RIVER OF ST. LAWRENCE, WITH CAPE BRETON ISLAND, ETC.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
THE GULF. [1]				
ISLAND OF ST. PAUL.				
Northern Extreme, Lighthouse	47 13 55	60 8 20	27 20	The observations of Capt. (afterwards Admiral) Henry Wolsey Bayfield, F.R.A.S., in H.M. surveying vessel *Gulnare*, 1827 to 1860.
Eastern side of Neck	47 13 9	60 8 30		
South Point, Lighthouse...	47 11 20	60 9 40		
MAGDALEN ISLANDS.				
Entry Isle, Lighthouse on S.E. side.....................	47 16 30	61 41 45		
South Cape, Lighthouse...	47 13 0	61 53 0		
Deadman Islet, W. point...	47 16 3	62 12 23		
Grindstone Island, Lt.-ho.	47 23 20	61 57 30		
Coffin Island, N.E. point...	47 37 30	61 23 0		
Bird Islet, Lighthouse......	47 50 40	61 8 20	27 35	
Byron or Cross Isle, E. pt.	47 47 53	61 24 30		
ANTICOSTI.				
East End, Heath Point, Lighthouse..................	49 5 20	61 42 0	29 10	
South Point, Lighthouse...	49 4 0	62 15 50		
S.W. Point, Lighthouse ...	49 23 45	63 35 30		
Cape Henry, S.E. extreme	49 47 45	64 22 45		
West Point, Lighthouse ...	49 52 45	64 31 40	28 30	
North Point, extremity ...	49 57 45	64 9 0		
Observation Cape............	49 40 0	62 41 45		
Bear Bay, entrance of the River	49 30 32	62 24 20		
LABRADOR, &c.				
Bradore Harbour, Flagstaff on Jones House	51 27 30	57 14 15	34 45	
Greenly Island, Lighthouse	51 22 35	57 10 50		
Belles Amours Point, S.E. extreme	51 26 34	57 25 53		
Whale Island, South end	51 21 0	57 41 0		
Mistanoque Id., E. point of Cove, N. side of Island...	51 15 43	58 12 3		
Flat Island, South end ...	50 45 45	58 47 20		
Mecattina Harbour, South point of Dead Cove	50 46 44	58 59 23		
Cape Mecattina..............	50 44 20	58 59 45		
Antrobus Point..............	50 33 40	59 16 30		
Hare Harbour, East side...	50 36 24	59 17 23		
St. Mary Island, North end	50 20 20	59 36 57		

GULF AND RIVER OF ST. LAWRENCE.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Wapitagun Harbour, East point of islet	50 11 40	60 1 23		The Surveys by Admiral H. W. Bayfield.
Cape Whittle, S.W. extreme of Lake Island	50 10 36	60 7 0	31 30	
Coacoacho Bay, S. point of Outer Islet	50 9 4	60 18 18		
Kegashka Bay, Islet at South end of beach	50 11 19	61 15 38		
Natashquan River, South point of entrance	50 6 57	61 47 58	30 30	
Little Natashquan Harbour, North Point Islet at head of bay	50 11 41	61 50 38		
Nabesippi River, entrance	50 14 0	62 18 0		
Appetetat Bay, East point	50 16 35	62 58 18		
Betchewun Harbour, S.E. point of Low Isle	50 14 18	63 10 32		
Clearwater Point, South extreme	50 12 27	63 27 6		
Mingan Harbour, Sandy Point	50 17 24	64 1 56	29 25	
Mingan Island, summit	50 12 48	64 7 31		
St. John River, East point of entrance	50 17 3	64 20 16		
Manitou Point, extreme	50 17 30	65 14 8		
St. Charles Point, South extreme	50 15 17	65 48 48		
Moisic River, S.W. point of entrance	50 11 16	66 4 38		
Carousel Island, Lightho.	50 5 40	66 22 40		
Seven Islands Bay, Storehouse, East side	50 13 0	66 24 4	27 30	
St. Margaret's Bay, S.W. extreme	50 2 25	66 44 43		
Cawee Islands, West point of Little Island	49 29 21	67 1 53		
Egg Island, Lighthouse	49 38 13	67 10 6		
Trinity Bay, S.W. point	49 23 39	67 18 8		
Point de Monts, Lightho.	49 19 45	67 21 58	25 0	
South extreme	49 18 41	67 23 18		
RIVER ST. LAWRENCE; NORTH SHORE.				
Goodbout River, Bar	49 18 25	67 36 30		
St. Nicholas Point, South extreme	49 15 47	67 50 4		
Manicougan Point, S.E. extreme	49 6 15	68 11 55	23 45	
Bersimis River, South point of entrance	48 55 23	68 36 54		
Jeremie, Trading Post	48 53 0	68 47 0		
Port Neuf Church	48 37 47	69 5 53		

RIVER ST. LAWRENCE.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Saguenay River, Lark Islet, Lighthouse	48	6	45	69	40	50	20	30	The Surveys by Admiral H. W. Bayfield.
Chicoutimi, Trading Post	48	26	5	71	4	51			
Isle aux Coudres, W. point of La Prairie Bay.........	47	24	40	70	24	52			
QUEBEC, Observatory... [2]	46	48	17	71	12	20	17	30	
Wolf Monument	46	48	38	71	12	31			
Time Ball, King's Bastion, Citadel	46	48	23	71	12	35			
RIVER ST. LAWRENCE; ABOVE QUEBEC.									
St. Jean des Chaillons, R. C. steeple	46	33	23	72	7	6			
C. Madeline, R. C. steeple	46	22	6	72	30	8			
Three Rivers, East steeple	46	20	48	72	32	10			
Point du Lac, R. C. steeple	46	17	21	72	41	20			
Sorel, Episcopal Church...	46	2	42	73	6	50			
Repentigny, R. C. steeple	45	44	28	73	26	49			
MONTREAL, McGill College	45	30	17	73	34	37			
Gate Island, North end, Lighthouse	45	30	22	73	33	5	14	0	
R. C. Cathedral ...... [8]	45	30	24	73	33	18			
RIVER ST. LAWRENCE; SOUTH SHORE.									
Orleans Isle, S.W. point...	46	50	58	71	8	42			Staff-Commander Maxwell, 1885-8.
Stone Pillar Island, Lt.-ho.	47	12	25	70	21	36	18	50	
Kamouraska, N.E. point of Crow Island	47	35	9	69	52	39			
Brandy Pots, Lighthouse	47	52	30	69	40	39			
Loup River, Pier Light, on North side of entrance...	47	50	57	69	34	0			
Red Island, Lighthouse ...	48	4	20	69	32	59			
Green Island, Lighthouse	48	8	17	69	25	6	20	40	
Bazade Rocks, N.E. one...	48	12	27	69	8	8			
Bicquette Island, Lightho.	48	25	18	68	53	20			
Bic Island, N.E. extreme of S.E. reef	48	25	9	68	48	23			
Barnaby Island, N.E. pt.	48	29	35	68	31	56			
Father Point, Lighthouse	48	31	25	68	27	40	22	20	
Camille Mount, summit 2,036 feet	48	28	36	68	12	50			
Little Metis, Lighthouse...	48	41	10	68	2	15			
Matane River, Lighthouse	48	52	0	67	33	0			
Cape Chatte, Lighthouse...	49	5	52	66	45	30	25	0	
Martin River, Lighthouse	49	13	20	66	9	0			
Cape Magdalen, Lightho.	49	15	40	65	19	15			
Fame Point, Lighthouse...	49	6	45	64	36	10			

NEW BRUNSWICK, ETC.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Great Fox Bay, centre of...	48 59 57	64 22 55		The Surveys by Admiral H. W. Bayfield, Staff-Comm. Maxwell, &c.
Cape Rozier, Lighthouse...	48 51 37	64 12 0		
Cape Gaspé, Lighthouse...	48 45 15	64 9 45	26 45	
NEW BRUNSWICK, &c.				
Cape Despair, Lighthouse	48 25 40	64 18 30		
Chaleur Bay, Macquereau Point, Lighthouse......	48 12 30	64 46 25		
Port Daniel, West point	48 9 10	64 56 55		
Paspebiac, Episcopal Ch.	48 1 47	65 15 6		
Bonaventure Point, S. extreme	48 0 17	65 26 26		
Carlton or Tracadigash Point, extremity	48 5 9	66 7 10		
Dalhousie Island, E. pt.	48 4 30	66 21 26	23 45	
Belledune Point, Lt.-ho.	47 55 15	65 58 15		
Black Rock, Station on	47 51 54	65 45 30		
Bathurst Harb., Carron Point, North Lightho.	47 39 20	65 36 40		
Mizzenette Pt., Station	47 50 2	64 58 48		
Caraquette Id., Lightho.	47 49 40	64 58 15		
Shippigan Harb., Fall's Wharf.....................	47 44 52	64 42 12		
Miscou Island, Lightho.	48 1 0	64 29 28	25 20	
Shippigan Gully, North entrance point	47 48 24	64 39 36		
Tracadie, North Gully, Lt.-house	47 33 20	64 51 25		
Tabisintac Gully, Lightho.	47 17 35	64 56 50		
Escuminac Point, Lt.-ho.	47 4 32	64 47 30	23 35	
Richibucto Head, Lightho.	46 39 40	64 42 30		
Buctouche River, Station at entrance	46 26 55	64 37 45		
Cocagne Head, ext. of cliff	46 21 31	64 31 41		
Shediac, Episcopal Church	46 14 15	64 33 32		
Cape Tormentine, Jouremain Island, Lighthouse	46 10 0	63 48 40		
Tignish Head, Bay Verte, Station	46 0 28	64 1 0		
Pugwash, Episcopal Ch....	45 51 14	63 39 18	22 40	
Amet Island, Lighthouse...	45 50 15	63 10 15		
Pictou Harbour, Lightho.	45 41 25	62 39 26		
Pictou Island, Lighthouse, East end.....................	45 49 10	62 30 20	23 30	
Cape George, Lighthouse	45 52 50	61 55 0		
Antigonish Harbour, North beacon	45 41 49	61 52 56		
Pomquet Island, Lightho.	45 39 40	61 44 30		
Gut of Canso, Light, North entrance.....................	45 41 45	61 28 50	23 10	

PRINCE EDWARD ISLAND—CAPE BRETON ISLAND.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
PRINCE EDWARD ISLAND.									
North Point, extr. of cliff	47	3	55	63	59	20	24	15	The Surveys by Admiral H. W. Bayfield; and Commanders Orlebar and Maxwell, &c.
West Point, Lighthouse ...	46	37	30	64	23	10			
Cape Egmont, Lighthouse	46	24	11	64	7	39			
Bedeque Harbour, Green's Wharf	46	23	32	63	47	26			
Cape Traverse, extreme of cliff	46	13	30	63	39	15			
St. Peter's Island, Lt.-ho.	46	7	20	63	10	30			
Charlottetown, Flagstaff on Fort George ...... [4]	46	13	55	63	7	23	23	45	
Prim Point, Lighthouse ...	46	3	10	63	1	50			
Panmure Island, Lightho.	46	8	47	62	27	40			
South Point, Wood Island, Lighthouse	45	57	15	62	44	5			
Cape Bear, Lighthouse ...	46	0	45	62	27	25			
East Point, Lighthouse ...	46	27	15	61	58	0	23	55	
St. Peter's Harbour, Sandhill, E. side of entrance	46	26	44	62	43	56			
Tracadie Harbour, Lt.-ho.	46	25	20	63	2	30			
Grenville Harbour, Lt.-ho.	46	31	0	63	29	0			
Richmond Bay, North extremity of Bunbury Id.	46	32	8	63	46	44			
Cascumpeque Harb., Light	46	48	16	64	2	15			
Cape Kildare, extreme......	46	52	57	63	57	50			
CAPE BRETON ISLAND.									
Bear Head, extreme	45	33	5	61	17	5	24	5	
Plaster Cove, North end of bridge	45	33	56	61	23	36			
Port Hood, Light............	46	0	0	61	31	30			
Sea Wolf Island, Lighthouse on summit	46	21	30	61	15	33			
Chetican Point, Lighthouse	46	36	22	61	2	58			
Cape St. Lawrence, N. ext.	47	2	54	60	35	36			
Cape North, Lighthouse...	47	2	15	60	23	30	26	50	
Cape Egmont, E. extreme	46	51	1	60	18	8			
Inganish, Lighthouse	46	41	20	60	20	5			
St. Anne Harb., Beach Pt.	46	17	41	60	32	25			
Ciboux Island, Lighthouse	46	23	12	60	22	30			
Carey Point, W. side of entrance of Great Bras d'Or	46	17	41	60	24	50			
Aconi or Cunet Point, extr.	46	20	32	60	17	16			
Sydney Harbour, Lighthouse on Flat Point......	46	16	12	60	7	22			
Table Head, extreme	46	13	20	59	57	20			
Flint Island, Lighthouse...	46	11	5	59	45	50			
Scatari Island, E. Lt.-ho.	46	2	13	59	40	10	25	40	
Menadou Harbour, N. pt.	46	0	29	59	49	58			

CAPE BRETON ISLAND.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Cape Breton, extreme......	45	57	30	59	47	3			The Surveys by Admiral H. W. Bayfield, and Commanders Shortland & Orlebar, R.N., 1827-60, &c.
Louisbourg, Lighthouse...	45	54	34	59	57	15			
Gabarus Bay, Ch. on cape	45	49	15	60	4	30			
Guyon Island, Lighthouse	45	46	10	60	6	35			
St. Esprit Island, Lightho.	45	37	·30	60	29	15			
Michaux Point, Station on extreme	45	34	11	60	41	0			
L'Ardoise, R. C. Church steeple	45	36	45	60	45	59			
St. Peter Island, S.W. ext.	45	35	54	60	48	50			
St. Peter Bay, Old Fort on West side of Haulover...	45	39	21	60	52	4	24	30	
Madame Island:									
Grande-digue, Lennox Passage, Station	45	35	49	61	1	11			
Arichat Harbour, Jerseyman Island, Lightho.	45	30	15	61	3	7	24	15	
Lighthouse on Marache Point	45	29	2	61	1	52			
Green Island, Lighthouse	45	28	45	60	58	45			

NOTES.

1. The GULF and RIVER of ST. LAWRENCE, together with the Coast of Newfoundland, and the coasts thence to Boston and Cape Cod, are described in the British American Navigator, published by the proprietor of this work.

2. Quebec.—In the early editions of this work, the longitude of Quebec was stated to be 71° 16′; "according to the observations of M. le Marquis de Lotbinière, M. Bédard, Director of the Seminary of St. Louis, and Captain Holland, M. Mechain computed the longitude to be 71° 10′, by several eclipses of Jupiter's first satellite, observed by Messrs. Lotbinière and Holland, and the passage of Venus, which Captain Holland observed in 1769. All the observations, made at different times, have given very coherent results."—Vide *American Trans.*, vol. i., &c.

The above passage, from "Analysis of a General Chart, &c.," Paris, 1786, shows the position in which Quebec was laid down on the charts, and it agreed with that given in the "Connaissance des Temps." But Quebec was afterwards exhibited considerably more to the eastward. Mr. Wright, in his chart of 1807, made it 70° 27′. The Requisite Tables, of 1802, gave latitude 46° 48′ 38″, longitude 71° 5′ 22″. Colonel Bouchette, in his work on Canada, 1815, gave 46° 48′ 49″ N., and 71° 11′ W. In the years 1819, 1820, and 1821, the officers of H.M.S. *Newcastle*, provided with four chronometers, made many observations in the river, and these observations may be judged of by the longitude in which they placed Quebec for three successive years, assuming Halifax as in 63° 33′ 40″; July 16th, 1819, 71° 12′ 48″; June 19th, 1820, 71° 13′ 14″; July 5th, 1821, 71° 12′ 25″. The greatest difference is 49″, and the mean of the whole is 1″ farther West than the longitude given in 1819.

From these and other observations combined, the late Mr. Purdy placed Quebec in longitude 71° 13′, in the charts, &c., which he constructed.

When the charts of Captain H. W. Bayfield were published in 1837, they were based upon a longitude of 71° 16′ W. for Quebec. This was shown to be in error nearly 3¾ minutes of arc, by electric telegraph signals transmitted between Quebec and Cambridge Observatory, in Massachusetts, by Lieutenant E. D. Ashe, R.N., in 1857.

The position of Cambridge, as will be seen in the Note on that longitude on a subsequent page, was settled as 71° 7′ 58·55″, and the mean difference between that Observatory and the Observatory in Mann's Bastion in the Citadel of Quebec, as determined by Lieutenant Ashe, is 0° 4′ 34·17″, which placed Quebec in 71° 12′ 32·72″. By the most recent observations, Quebec Observatory is placed in long. 71° 12′ 20″, as given in the Table.

3. MONTREAL.—The longitude of Gate Island, opposite the Cathedral and the Hotel Dieu, is given by Captain Bayfield in 73° 34′ 38″. Lieutenant Ashe, R.N., as stated above, in continuation of his work on electric time-signals, obtained the difference of longitude between Quebec and Viger Square, 680 ft. West of Gate Island, on March 12th, 1857, as 2° 20′ 45·5″, which makes it in longitude 73° 33′ 18·12″. as shown in the Table.

4. CHARLOTTETOWN AND PRINCE EDWARD'S ISLAND.—The position of the flagstaff in the Fort of Charlottetown was given by Rear-Admiral Bayfield as lat. 46° 15′ 55″ N., long. 63° 7′ 28″ W. It had been before placed 3′ more to the West, but the exact difference of longitude between this point and Quebec has been determined by the electric telegraph as 8° 5′ 26″.

The VARIATION of the COMPASS is now *decreasing* on the shores of the Gulf and River of St. Lawrence, at the rate of 1′ per annum.

14. NOVA SCOTIA, &c.—(SOUTHERN COASTS.)

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
SABLE ISLAND [1]				
Lighthouse 1½ mile from East end	43 58 30	59 46 0	22 55	The Surveys by Admiral H. W. Bayfield; and Commanders Shortland & Orlebar, R.N., 1827-60, &c.
Lighthouse on West end	43 56 20	60 6 0		
NOVA SCOTIA. [2]				
Cranberry Island, Lightho.	45 20 0	60 55 40	24 5	
Canso Harbour, Cutler Id., S.E. extreme	45 20 42	60 59 27		
Steeple of Church	45 20 10	60 59 25		
White Head Island, Lt.-ho.	45 11 58	61 8 27		
White Haven, Observation Station in Marshall Cove	45 14 37	61 11 43		
Berry Head, Lighthouse	45 11 40	61 18 40		
New Harbour Head, Nob	45 9 7	61 28 21		
Green Island, Lighthouse on South point	45 6 15	61 32 30		
Harbour Island, N.E. point	45 8 25	61 36 15		
Isaac Harbour, Red Head, summit	45 9 39	61 38 50		
Country Harbour, Station opposite Widow Point	45 14 41	61 47 6	23 15	
Hollins Head	45 4 19	61 44 57		

NOVA SCOTIA.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Wedge Island, Lighthouse	45	0	36	61	52	40			The Surveys by Admiral H. W. Bayfield; and Commanders Shortland & Orlebar, R.N., 1827-60, &c.
St. Mary River, Episcopal Church	45	5	30	61	57	15			
Liscomb Island, Lightho.	44	59	20	61	57	50			
Mary Joseph Harbour, Lobster Point, extreme	44	57	52	62	4	57			
Beaver Island, Lighthouse	44	49	45	62	20	30			
Salmon River, Church ...	44	54	32	62	23	0			
Sheet Harb., ½ mile N.W. from Watering Cove ...	44	54	11	62	30	37			
Taylor Head, summit......	44	47	24	62	32	50			
Pope Harbour, Harbour Island, Lighthouse	44	47	40	62	38	50	22	5	
Ship Harbour, Islet near Salmon Point	44	46	59	62	48	50			
Egg Island, Lighthouse ...	44	39	55	62	51	40			
Jedore Harb., Marsh Point	44	43	19	63	0	15			
Jedore Rock, centre.........	44	39	49	63	0	20			
Jedore Head, extreme......	44	40	22	63	2	40			
Graham Head, summit ...	44	37	44	63	17	23			
Devil Island, Lighthouse	44	34	48	63	27	30			
Halifax Harbour, Lightho., Maugher Beach	44	36	6	63	32	0	21	5	
HALIFAX, Dockyard Observatory .... [8]	44	39	38	63	35	21			
Sambro Island, Lighthouse	44	26	11	63	33	40			
Betty Island Lighthouse ...	44	26	20	63	45	50			
St. Margaret Bay, S.W. Island, South end	44	30	15	63	59	33			
Green Island, off Mahone Bay, Lighthouse	44	22	58	64	2	50			
Lunenburg Harbour, Cross Island, Lighthouse	44	18	43	64	9	58			
West Ironbound Island, Lighthouse	44	13	43	64	16	20	20	0	
Metway Head, Lighthouse	44	6	10	64	32	15			
Coffin Island, Lighthouse, Liverpool Harbour	44	1	58	64	37	35			
Mouton Island, South Rock	43	52	58	64	45	28			
Shelburne or Cape Roseway, Lighthouse on Macnutt Island..................	43	37	17	65	15	45			
Negro Island, Lighthouse	43	30	55	65	21	0			
Baccaro Point, Light on West side of Port Latour	43	26	54	65	28	12			
Brasil Rock	43	21	25	65	26	48			
Cape Sable, Lighthouse ...	43	23	20	65	37	10	18	0	
Seal Island, Lightho. [4]	43	23	34	66	0	50			
Cape Fourchu, near Yarmouth, Lighthouse	43	47	30	66	9	20			
Bryer Island, Lighthouse	44	14	57	66	23	32	18	30	
Annapolis Basin, Point Prim, Lighthouse.........	44	41	30	65	47	10			
Black Rock Point, Lt.-ho.	45	10	10	64	45	50			

NOVA SCOTIA—NEW BRUNSWICK.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Horton Bluff, Lighthouse	45 6 30	64 13 20	21 0	The Surveys by Comm. Shortland, R.N., Admiral Bayfield, and Commander Orlebar, R.N., to 1867, &c.
Partridge Island, in the Mines Channel	45 21 50	64 20 10		
Cape Chignecto	45 19 35	64 56 45		
Isle Haute, Lighthouse	45 14 55	65 0 40		
Cumberland Basin, Ward Point, Lighthouse	45 43 45	64 29 40		
NEW BRUNSWICK.				
Hillsborough, Light	45 55 15	64 38 0	19 50	Lieutenants Harding and Kortright, R.N.
Cape Enragé, Lighthouse	45 35 35	64 46 55		
Quaco Head, Lighthouse	45 19 30	65 31 55		
Cape Spencer, Lighthouse	45 12 5	65 54 30		
Partridge Island, Lightho.	45 14 3	66 3 5		
City of St. John, South end	45 16 0	66 3 15		
Point Lepreau, Lighthouse	45 3 30	66 27 39		
Beaver Harbour, Lightho.	45 3 45	66 44 0		
South Wolf, Lighthouse	44 56 25	66 44 0		
Passamaquoddy Bay, St. Andrew's, Lighthouse	45 4 10	67 2 50		
Grand Manan Id., Swallow Tail, or N.E. Point, Lt.-house	44 45 55	66 44 5		
Gannet Rock, Lighthouse	44 30 35	66 47 0		

NOTES.

1. SABLE ISLAND.—On this island is an establishment for the relief of shipwrecked mariners. It was founded, in 1808, by the Provincial Legislature of Nova Scotia, at the recommendation of the late Sir John Wentworth, then Lieutenant-Governor; and has since proved the means of saving many lives.

2. NOVA SCOTIA.—The coasts of Nova Scotia were first laid down from the surveys of Mr. Des Barres, with emendations by Mr. A. Lockwood, R.N., and various corrections in position by Admiral Owen and others. After the completion of the survey of the Canadian coasts, our Admiralty Surveyors, Admirals Bayfield and W. F. Owen, with Captains Shortland and Orlebar, re-examined the South-East shores of Nova Scotia and the Bay of Fundy, the results of which are shown in the Table.

3. HALIFAX.—In former editions of this work the following appears:—"The latitude of the Naval Yard of Halifax, from observations very carefully made by the officers of H.M.S. *Niemen*, in 1842, was 44° 39′ 37″. This was gained by eleven *meridian* altitudes with the artificial horizon, and several observations made on each side of noon at small intervals; the mean true altitudes being computed from the hour angles. The longitude, 63° 33′ 48″, was obtained as the mean result of more than 30 sets of lunar distances. We formerly gave the longitude of M. Des Barres, &c., as 63° 32′ 40″, and therefore presume that a statement of 63° 37′ 48″, which has lately appeared, is 4′ too far West."

Captain Bayfield assumed the longitude of the Dockyard, in his survey, to be 63° 37′ 48″, as previously stated. The late Admiral W. F. Owen, in H.M.S. *Columbia*, in 1844, made it 63° 35′ 23″ W. The late respected Lieutenant Raper made it, as a secondary meridian, 63° 37′ 36″, or nearly the same as Captain Bayfield.

In the determination of this, and of other longitudes, the Electric Telegraph has decided the question beyond controversy.

The difference of longitude between Cambridge Observatory, Massachusetts, and that of Halifax Dockyard, was determined, electrically, by Professor Bond, and Captain Shortland, R.N., to be 0h 30m 9s in time, or 7° 32′ 23·45″ in arc. This meridianal difference applied to the longitude of Cambridge, 71° 7′ 58·55″, as then determined, made Halifax Dockyard Observatory to be in 63° 35′ 35″ W. of Greenwich. It is now considered to be 63° 35′ 21″, as given in the Table.

4. Seal Island.—" M. Des Barres placed the southernmost point of the southern Seal Isle in lat. 43° 25′ 25″, and long. 66° 0′ 35″. Later charts have it in lat. 43° 26′ 35″; but our correspondent, Lieutenant Hare, gave the latitude of the South point 43° 22′ 23″, or *four miles more to the southward.* This result, since confirmed, will account for so many ships having been yearly cast away, on coming out of the Bay of Fundy. A very strong indraught, both on the ebb and flood, sets toward the isles, and in the vicinity, equal to 4 knots an hour, and *they should not be approached without a commanding breeze.*" The lighthouse should obviate this.

The Variation of the Compass is *increasing* on the Coast of Nova Scotia, &c., at the rate of 1¼′ to 3′ per annum.

15. THE UNITED STATES.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
MAINE.				
Eastport	44 54 12	66 59 5		The Triangulation made for the United States Coast Survey, under the superintendence of Professor A. D. Bache, &c. ⁂ For the purposes of the Survey, the Coast of the United States was divided into eleven sections (nine of which are on the Atlantic Coast), in all of which the work was carried on simultaneously, the Survey being in different stages of progress in the several sections. These several sections are defined as follows :—Section I., from Passamaquoddy Bay to Point Judith, Section II., from Point Judith to Cape Henlopen. Section III., from Cape Henlopen to Cape Henry. Section IV., from Cape Henry to Cape
Passamaquoddy Bay, Quoddy Head, Lightho.	44 48 54	66 57 1	18 50	
Little River Island, Lt.-ho.	44 39 45	67 12 5		
Machias Seal Ids., Lt.-ho. on East one (British) ...	44 30 7	67 6 5		
Machias Bay, Libby Island, Lighthouse	44 34 5	67 22 2		
Moose-a-bec or Moose Peak, Mistake Island, Lightho.	44 28 27	67 31 55		
Petit Manan, Lighthouse on South end	44 22 2	67 51 51		
Mount Desert Id., Great Head, S.E. end	44 19 40	68 10 25		
Mount Desert Rock, Light	43 58 7	68 7 42	16 55	
Isle au Haut, Light on Saddle Back Islet	44 0 51	68 43 35		
Matinicus Rock, Lightho.	43 47 0	68 51 18		
Penobscot Bay, Owls Head, Lighthouse	44 5 31	69 2 39		
Cape Rosier	44 18 30	68 49 30		
Manheigan Island, Lt.-ho.	43 45 52	69 18 57	15 45	

THE UNITED STATES.

	LAT. N.			LONG. W.			VAR. WEST, 1895.	
	°	′	″	°	′	″	°	′
Cape Small	43	42	0	69	50	0		
Portland Head, Lighthouse	43	27	22	70	12	29		
Cape Elizabeth, East Light	43	33	56	70	12	1		
Fletcher's Neck, Light on Wood Island	43	27	28	70	19	45	14	30
Cape Porpoise Harbour, Light on Goat Island	43	21	27	70	25	31		
Cape Neddick, Lighthouse	43	9	45	70	35	30		
York Harbour, Light on Boon Island	43	7	16	70	28	36		
NEW HAMPSHIRE.								
Agamenticus Hill, summit	43	13	28	70	41	41	14	5
Portsmouth Harb., Whales Back Light	43	3	30	70	41	48		
Isles of Shoals, White Id., Lighthouse	42	58	0	70	37	25	13	45
MASSACHUSETTS.								
Newbury Port, East Light on Plum Island	42	48	25	70	49	6		
Cape Ann, North Light on Thatcher Island	42	38	19	70	34	30		
Light on East point	42	34	47	70	39	58	13	30
Baker's Island, Lighthouse	42	32	10	70	47	10		
Marblehead, Light at the entrance	42	30	18	70	50	2		
Nahant Head	42	25	0	70	54	30		
Boston, State House... [1]	42	21	28	71	3	50	12	35
Cunard Wharf, Flagstaff	42	21	48	71	2	30		
CAMBRIDGE Observatory, Dome [2]	42	22	48	71	7	39		
Boston Bay, Lighthouse on Little Brewster Id.	42	19	39	70	53	25		
Minot's Ledge, Light	42	16	9	70	45	34		
Scituate Harbour, Light on North Point	42	12	15	70	42	55		
Plymouth Harbour, Light on North side of entrance	42	0	12	70	36	4		
Sandwich, Church Spire	41	45	26	70	29	10		
Barnstaple, Sandy Neck, Lighthouse	41	43	20	70	16	52		
Billingsgate Point, Lt.-ho.	41	52	16	70	4	9		
Cape Cod, Provincetown, Orthodox Church Spire	42	3	2	70	11	31		
Race Point, Lighthouse	42	3	48	70	14	36		
Highlands Lighthouse	42	2	21	70	3	39	13	15
Nausett, Centre Light	41	51	37	69	57	4		
Monomoy Island, Lighthouse at South end	41	33	32	69	59	33		

AUTHORITIES.

The TRIANGULATION made for the UNITED STATES COAST SURVEY, under the superintendence of Professor A. D. Bache, &c.

Fear. Section V., from Cape Fear to St. Mary's River. Section VI., from St. Mary's River to St. Joseph's Bay. Section VII., from St. Joseph's Bay to Mobile Bay. Section VIII., from Mobile Bay to Vermilion Bay. Section IX., from Vermilion Bay to the Rio Grande. Section X., Coast of California, San Diego Bay to 42nd parallel. Section XI., Coast of Oregon, &c., 42nd to 49th parallel. The Tables give the latitudes and longitudes of some of the trigonometrical points in each section. The manner in which these data have been obtained may be briefly explained here.

In each section a base line of from 5 to 10 miles in length was measured with all possible accuracy. A series of triangles, deriving the length of their sides from this base, was then established along the coast, by the measurement of the angles between the intervisible stations. In this primary series the triangles were made as large as the nature of the country would permit, because the liability to error increases with the number of triangles.

On the bases furnished by the sides of the primary triangles, a secondary triangulation was next established, extending along the coast, and over the smaller bays and sounds, and determining a large number of points at distances of a few miles apart.

The distances between the points thus determined, were liable to an average error of about one foot in six miles.

As, on the completion of the primary triangulation in each section, the several series form

THE UNITED STATES.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Nantucket Island, Brant Point, Lighthouse	41 17 21	70 5 33		The Triangulation made for the United States Coast Survey, under the superintendence of Professor A. D. Bache, &c.
Light on Great or N.E. Point	41 23 22	70 2 45		
Sankaty Head, Lightho.	41 16 59	69 57 55		
Tuckanuck Id., West end	41 18 10	70 16 50		
Davis South Shoal, Light-vessel, about	40 54 51	69 49 26	12 10	one connected chain, the different bases afford verifications of each other, and of the triangulation connecting them.
Muskeget Island, N.E. pt.	41 20 12	70 17 20		
Martha's Vineyard, Cape Poge, Lighthouse	41 25 14	70 27 5		
Edgartown, Spire	41 23 16	70 30 20		
Holmes' Hole, Spire	41 27 13	70 36 0		
West Chop, or North Point, Light	41 28 49	70 36 0		
Indian Hill, on N.W. side	41 25 44	70 40 12		
Gay Head, Lighthouse	41 20 52	70 50 8	11 45	
No Man's Land, centre	41 15 9	70 48 15		
Cuttyhunk, Lt. on S.W. pt.	41 24 50	70 56 59		
Nashon Island, Lighthouse	41 28 6	70 45 28		
Nobska Lighthouse	41 30 55	70 39 19		
Mattapoiset, Lt. on Ned's Point	41 39 1	70 47 45		
New Bedford, Pope Island	41 38 20	70 54 25		
Seconnet Point, East Rock	41 27 2	71 11 15		
Rhode Island.				
Newport, Spire	41 29 12	71 18 30	11 25	
Beaver Tail Lighthouse	41 26 56	71 23 59		
Quaker Hill, near N. end	41 34 55	71 14 50		
Bristol, Court House	41 40 10	71 16 10		
Providence, Unitarian Ch.	41 49 26	71 24 35		
Point Judith, Lighthouse	41 21 33	71 28 54		
Block Island, Lt. on N. pt.	41 13 33	71 34 34	10 50	
Beacon Hill, on West side	41 10 40	71 35 27		
Watch Hill, Lighthouse	41 18 12	71 51 32		
Connecticut and New York.				
Long Island Sound:				
Montauk Point, Lt.-ho.	41 4 13	71 51 27	10 30	
Plum Island, Lighthouse	41 10 23	72 12 43		
Stonington, Light	41 19 36	71 54 36		
New London, Lightho.	41 19 0	72 5 25		
Connecticut River, Light on Saybrook Point	41 16 15	72 20 37		
Faulkner Island, Lt.-ho.	41 12 43	72 39 14		
Newhaven, Episc. Ch.	41 18 11	72 55 49	9 50	
Light on Long Wharf	41 17 34	72 54 56		
Stratford Point, Lightho.	41 9 5	73 6 13		
Stratford Shoal or Middle Ground, Lightho.	41 3 36	73 6 6		
Throg's Neck, Lightho.	40 48 17	73 47 30		

THE UNITED STATES.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Long Island Sound:				
Sands Point, Lighthouse	40 51 55	73 43 43		The TRIANGULATION made for the UNITED STATES COAST SURVEY, under the superintendence of Professor A. D. Bache, &c.
Eaton's Point, Lightho.	40 57 12	73 23 45		
Old Field Point, Lightho.	40 58 34	73 7 8		
Horton's Point, Lightho.	41 5 4	72 26 46		
Long Island, South side, Shinnecock Bay, Pondquogue Point, Lightho.	40 50 55	72 30 16		
Fire Island, Lighthouse ...	40 37 55	73 13 9		
New York, City Hall	40 42 43	74 0 15	8 30	
Navy Yard, centre of islet lying off it .... [3]	40 42 10	73 58 0		
NEW JERSEY.				
Sandy Hook, Lighthouse	40 27 40	74 0 9	8 5	
Highlands of Navesink, Lt.	40 23 45	73 59 11		
Barnegat Inlet, Lighthouse	39 45 52	74 6 24		
Little Egg Harb., Tucker's Beach, Lighthouse	39 30 22	74 17 8	7 10	
Absecum Inlet, Lighthouse on South side	39 21 59	74 24 52		
Hereford Inlet, Lighthouse	39 0 15	74 47 40		
DELAWARE BAY.				
Cape May, Lighthouse ...	38 55 50	74 58 10	6 15	
Egg Island, Lighthouse ...	39 10 45	75 8 37		
Cohansey, Lighthouse......	39 20 30	75 22 0		
Brandywine Shoal, Lt.-ho.	38 59 0	75 7 20		
Philadelphia, Girard Coll.	39 58 23	75 11 0		
South end of islet.........	39 56 15	75 8 45	6 25	
Wilmington, Light at Christiania River	39 43 15	75 31 45		
Cross Ledge, Lighthouse	39 9 45	75 14 30		
Cape Henlopen, High Lt.	38 46 33	75 5 19		
VIRGINIA, &c.				
Indian River Inlet, entr.	38 36 35	75 4 0		
Fenwick Island, Lightho.	38 27 0	75 3 45		
Assateague Island, Lt.-ho.	37 54 37	75 21 10		
Hog Island, Lighthouse at South end	37 23 18	75 41 30		
Cape Charles, Smith Island, Lighthouse.................	37 7 20	75 52 48	4 20	
CHESAPEAKE BAY.				
Old Point Comfort, Lt.-ho.	37 0 3	76 18 10		
York Spit, Lighthouse......	37 12 31	76 14 40		
Wolf Trap Shoal, Lightho.	37 23 25	76 10 50		
Smith Point, Lighthouse	37 53 35	76 11 15		
Cove Point, Lighthouse ...	38 22 50	76 22 30		

THE UNITED STATES.

	LAT. N.			LONG. W.			VAR. 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Thomas Point, Lighthouse	38	54	0	76	26	0	WEST.		The TRIANGULATION made for the UNITED STATES COAST SURVEY, under the superintendence of Professor A. D. Bache, &c.
Baltimore, Lazaretto Light	39	15	30	76	33	50			
WASHINGTON, Capitol Dome	38	53	25	77	2	0	4	10	
Naval Observatory ... [4]	38	53	39	77	2	45			
NORTH CAROLINA.									
Cape Henry, Lighthouse...	36	55	29	76	0	5			
Currituck Beach, Lightho.	36	22	32	75	49	33			
Entrance to Pamplico Sound, Body Id., Lt.-ho.	35	49	0	75	33	20			
Stevenson Point, N. side of Albemarle Sound ... [5]	36	6	13	76	10	23			
Cape Hatteras, High Lt.-house	35	15	11	75	30	59	3	35	
Extremity	35	13	50	75	31	5			
Ocracoke Inlet, Light on West end of island	35	6	31	75	59	15			
Cape Lookout, Lighthouse	34	37	20	76	31	7			
Extremity	34	34	50	76	32	15			
Beaufort Inlet, Fort Macon	34	41	40	76	40	45			
Bogue Inlet, entrance......	34	38	30	77	6	0			
Cape Fear, Lighthouse on Bald Head..............	33	52	13	77	59	50	1	30	
South extreme	33	49	55	77	56	15			
Little River, entrance......	33	50	45	78	33	40			
SOUTH CAROLINA.									
George Town, Light at entrance of Pedee River...	33	13	21	79	10	54			
Cape Romain, Light on Raccoon Kay..............	33	1	3	79	22	30			
Bulls Bay, Light at North end of Bulls Island	32	55	20	79	33	49			
Charleston, Main Lighthouse on Morris Island	32	41	44	79	52	45	0	0	
St. Michael's Church [6]	32	46	33	79	55	33			
North Edisto River entr....	32	33	30	80	11	0			
Hunting Island, Lightho.	32	23	20	80	25	15			
Port Royal, Martin's Industry, Lightvessel	32	5	31	80	35	7			
Hilton Head Island, High Light	32	9	50	80	44	25			
GEORGIA.									
Savannah River, Tybee Lighthouse	32	1	21	80	50	33	EAST. 1	0	
Exchange Spire	32	4	53	81	5	14			
Sapelo Sound, Bar, S. end of St. Catherine Island	31	33	0	81	10	45			
Doboy Sound, Sapelo Id., Lighthouse on South end	31	23	40	81	17	15			

THE UNITED STATES.

	LAT. N.	LONG. W.	VAR. EAST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
St. Simon Sound, Lighthouse on North side......	31 8 0	81 24 15		The **Triangulation** made for the **United States Coast Survey**, under the superintendence of Professor A. D. Bache, &c.
St. Andrew Sound, Light on Little Cumberland Id.	30 58 30	81 25 0		
Florida.				
St. Mary's River, Lightho. near N. end of Amelia Id.	30 40 15	81 26 35		
Fernandina, railroad wharf	30 40 17	81 27 42		
St. John's River, Lightho.	30 23 40	81 25 30		
St. Augustine Inlet, Lighthouse on Anastasia Id....	29 53 0	81 17 30		
Mosquito Inlet, entrance	29 4 0	80 54 45		
Cape Canaveral, Lightho.	28 27 37	80 31 30	1 40	
Jupiter Inlet, Lt.-ho. S. of	26 56 54	80 4 48		
Cape Florida, Biscayne Kay [7]	25 41 0	80 9 24		
Florida Reefs, Lighthouse on Fowey Rocks	25 35 24	80 5 50	2 10	
Alligator Reef, Lightho.	24 51 2	80 37 10		
Sombrero Shoal, Lt.-ho.	24 37 36	81 6 48		
American Shoal, Lt.-ho.	24 31 15	81 31 30		
Sand Kay, Lighthouse...	24 27 15	81 52 42		
Rebecca Shoal, Lightho.	24 34 45	82 35 0		
Key West, Lt. on S.W. pt.	24 32 58	81 48 4	2 40	
Naval Storehouse [8]	24 33 25	81 48 24		
Marquesas, S.W. point ...	24 32 54	82 10 0		
Dry Tortugas, Lighthouse on Bush Kay, Fort Jefferson	24 37 47	82 52 58		
Cape Sable	25 6 30	81 5 0		
Cape Romano	25 50 0	81 41 45		
Sanibel Island, Lighthouse	26 27 15	82 0 30		
Gasparilla Island, Lt.-ho.	26 43 5	82 15 45	2 40	
Tampa Bay, Egmont Kay, Lighthouse	27 36 4	82 45 40		
Anclote Kays, Lighthouse	28 10 15	82 50 30		
Cedar Kays, Lighthouse on Seahorse Kay	29 5 45	83 3 30	2 40	
St. Mark's Harbour, Lt.-ho.	30 4 24	84 10 37		
Dog Id., Lt. near W. end	29 46 0	84 33 30		
Cape St. George, Lightho.	29 35 0	85 2 30		
Cape St. Blas, Lighthouse	29 40 0	85 21 30		
St. Andrew Island, Hurricane Island, S.E. end ...	30 4 30	85 39 0		
Santa Rosa Island, E. end	30 23 0	86 29 0		
Pensacola Bay, Lighthouse	30 21 5	87 18 30	4 20	
Alabama.				
Mobile Point, Fort Morgan [9]	30 13 48	88 1 25	4 40	
Dauphin Island, West end	30 15 0	88 4 45		

THE UNITED STATES.

	LAT. N.	LONG. W.	VAR. EAST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Mobile, Episcopal Spire ...	30 41 26	88 3 0		The TRIANGULATION made for the UNITED STATES COAST SURVEY, under the superintendence of Professor A. D. Bache, &c.
Horn Island, Lighthouse...	30 13 21	88 32 0		
MISSISSIPPI & LOUISIANA.				
Ship Island, Lighthouse on West point..................	30 12 30	88 58 1		
Chandeleur Island, Lighthouse on North point ...	30 2 45	88 52 30		
Entrance of the Mississippi, Pass a L'Outre Lt.-ho.	29 11 30	89 2 30	5 10	
South Pass, pier entrance	28 59 30	89 8 15		
S.W. Pass Lighthouse...	28 58 28	89 23 30		
New Orleans, City Hall [10]	29 57 45	90 6 45		
Grand Pass, Lighthouse ...	29 14 45	89 58 30		
Timballier Bay, Lt.-ho. on West side of entrance ...	29 1 45	90 19 15		
Ship Shoal, Lighthouse ...	28 55 5	91 4 30		
Atchafalaya Bay, Point au Fer, Tower	29 19 50	91 21 30	6 10	
Vermilion Bay, S.W. Pass	29 35 0	92 2 45		
Sabine River, Lighthouse on Brant Point............	29 43 55	93 50 19		
TEXAS.				
Galveston Bay, Lighthouse on Bolivar Point	29 22 10	94 45 5	7 30	
Galveston, Court House...	29 18 14	94 46 33		
Matagorda Island, Lighthouse on East point......	28 20 17	96 25 5		
Aransas Pass, Lighthouse on North side	27 53 23	97 1 20		
Brazos Santiago, Isabel Pt.	26 4 36	97 12 28	7 55	

NOTES.

GENERAL NOTE.—In the year 1807, the United States Legislature determined upon the survey of the coast. This was not properly commenced until 1817, when some base lines were measured, and triangles taken. In 1832 the operations were resumed, under its original superintendent, Mr. F. R. Hassler.

In 1842 a plan was drawn up by Congress for its further organization, by which it was continued under the able superintendence of Professor A. D. Bache. In the conducting of this extensive survey, every refinement and appliance to ensure accuracy has been employed, and many new and important discoveries in geodetic science have been made.

As shown in the Note on pp. 66-67, the coasts of the United States were divided into eleven sections, of which two are composed of the Pacific Coasts, and the geographic connexion between America and the rest of the world, is mainly dependent on the position of the Observatory of Cambridge near Boston.

1. Boston.—Dr. Bowditch, from six astronomic observations, viz., two transits and four solar eclipses, made the longitude of Boston as 4h 44m 16·6s; and it was the opinion of Dr. Bowditch that this longitude was more accurately ascertained than that of any other place in the United States. The State of Massachusetts was surveyed trigonometrically, by Simeon Borden and Robert Treat Payne, Esqrs., and the survey was based on the position of Boston State House. "From observations in 1829 and 1830," says Mr. Borden, "I made the longitude of the State House as 4h 44m 14·6s, and by the great solar eclipse, May 15th, 1836, 4h 44m 19·6s; mean of the whole, 71° 4' 18·5"." The latitude deduced as 42° 21' 22·7", was from 686 observations.

2. CAMBRIDGE OBSERVATORY.—The longitude of the Observatory of Cambridge near Boston, is the primary meridian of the greater portion of N.W. America, inasmuch as the longitudes of most other places have been referred to it by triangulation, or by electric signal. Its relation to Greenwich has also employed years of assiduous labour and consummate skill, and may now be considered as entirely established, within probably an insignificant amount of error.

Prior to the year 1849, the astronomic observations systematically carried on there had resulted in a longitude assumed as 71° 8' 0" West of Greenwich. When the positions of the United States Coast Survey Stations were published in 1851, it was assumed as 71° 7' 22·5", from the following data:—Moon culminations at various Observatories referred to Cambridge, 4h 44m 28·4s; by eclipses and occultations in the same manner, 4h 44m 29·6s; and by chronometric differences to that date 4h 44m 30·1s. This latter determination was afterwards assumed by Professor Bond to be very nearly the true longitude.

But in 1855 the chronometric operations were again resumed early in January, and the first meridional distance was carried by the steamer *America*, June 5th, and the last by the return of the *Africa* to Boston, October 26th, 1855. There were six voyages across the Atlantic, between Boston and Liverpool, and the total number of chronometers used was fifty-two, and the final longitude determined was as follows:—

	h	m	s
Voyages from Liverpool to Cambridge	4	32	31·92
Voyages from Cambridge to Liverpool	4	32	31·75
Mean	4	32	31·84
Liverpool West of Greenwich		12	0·05
Resulting longitude	4	44	31·89 or

Cambridge 71° 7' 58·55" West of Greenwich. This longitude, which is 1·79s in excess of the longitude of 1851, is a very close approximation to that established by Dr. Bowditch and Mr. Borden for Boston as in the previous Note, and is also nearly identical with that of New York, as obtained by Mr. Dent's chronometers in 1839. Later observations make the longitude to be 71° 7' 39" W., as given in the Table.

3. New York.—In the *Ladies' and Gentleman's Diary*, or *United States Almanac*, for 1820, Mr. Nash, the Editor, having the reputation of an excellent observer, gave particulars of a great many meridian and circum-meridional observations taken at his school, Broadway, New York, from which he inferred the latitude of No. 331, Broadway, as 40° 42' 58". The difference of latitude, trigonometrically found, between Mr. Nash's and the City Hall, was somewhat less than 1,300 feet, which, assumed as 13", gives the latitude of the City Hall 40° 42' 45", *i.e.*, allowing 40° 42' 58" as the latitude of No. 331, Broadway. By observations of a solar eclipse, which Dr. Bowden observed at New York, he found the difference of longitude between Greenwich and Colombia College, equal to 74° 0' 45" W. On the 29th of May, 1818, at a few minutes past noon, the longitude of

No. 881, Broadway, by the mean of three distances of the sun and moon, appeared to be 74° 0′ 42″, and Mr. Nash adds, "I am inclined, for the present, to place the City Hall in 74° W."

By seventy lunar distances, forty of *Pollux* East, and thirty of *Aldebaran* West of the moon, in December, 1822, and January, 1823, Captain (afterwards General Sir Edward) Sabine gave the longitude of the cupola of Colombia College, New York, as 74° 8′ 27″, and the latitude which he assigns to it is 40° 42′ 43″. Mr. De Witt, on his survey of the province, gave the longitude as 74° 8′.

The chronometers of Messrs. Arnold and Dent, however, appeared to have decided the longitude of New York. Four of them were embarked in the *British Queen* steam-vessel, under the care of Captain Roberts, on her first voyage from England to America, in July and August, 1839, and gained the longitude of the City Hall in New York, as $4^h\ 56^m\ 8{\cdot}85^s = 74° 0′ 49″$. A second experiment was made on the next voyage of the same vessel, in October and November of the same year, by another set of four chronometers, and by this the difference of longitude between the Observatory at Greenwich and the City Hall, New York, appeared to be $4^h\ 56^m\ 0{\cdot}24^s$, say 74° 0′ 10″. M. Daussy, the French Hydrographer, had previously given it in the *Connaissance des Temps* as $4^h\ 56^m\ 0{\cdot}72^s$, or 74° 0′ 11″.

By the determination of the United States Coast Survey, from data up to 1851, it was in longitude 74° 0′ 8·09″; but, by the subsequent correction of the Cambridge longitude, as shown before, it is in 74° 0′ 15″, as in the Table, very nearly identical with the determination of M. Daussy and Mr. Dent.

4. WASHINGTON.—In our former editions, the Dome of the Capitol was placed in longitude 77° 0′ 20″, agreeing closely with the State Survey of 1816. Later observations place it in 77° 2′ 0″ W.

SEATON STATION, in the City of Washington, is the point to which all telegraphic differences of longitude are referred, and which have now placed it in connection with most of the important places on the Coasts of North-West America, and established, beyond controversy, their true relative longitudes.

5. NORTH CAROLINA.—The longitudes of the coasts South of Cape Henry, at the Chesapeake, as far as Cape Fear, or Section IV. of the United States Coast Survey, are dependent on that of Stevenson Point, the West Point of Little River, on the North side of Albemarle Sound. The base line upon which the triangulation was established, was measured upon Body Island, on the coast of Pamplico Sound, the South end of it being near the Lighthouse.

6. CHARLESTON.—The longitude of Charleston was obtained from Seaton Station, in Washington, by Electric Telegraph, in 1850, by Professor Walker and Lieutenant Gibbes. Section V. of the United States Coast Survey system is thus connected with the rest of the series.

7. CAPE FLORIDA, &c.—In 1845, Captain Edward Barnett, R.N., made a running survey of the Coast of Florida and the adjacent banks. His longitudes found by eight chronometers by meridian distance from Havana, and in other portions of this region, have been found very consistent. He placed Cape Florida in longitude 80° 8′ 0″ W.

But the United States Surveyors make this position a primary point for the longitudes in Section VI. of the Coast Survey, and they made it, according to their estimate of 1851, 80° 5′ 0″, and in 1859, 80° 9′ 29″, or 6¼′ farther West than Captain Barnett. Yet Sand Kay was placed by the United States authorities, in November, 1852, as 81° 52′ 43″, while Captain Barnett's longitude was 81° 51′ 12″, a difference of only 1½′.

8. KEY WEST.—The position of the Naval Storehouse was determined by United States officers in 1875-6, the longitude being ascertained by electric telegraph.

9. MOBILE.—Fort Morgan, on Mobile Point, is made the primary station of Sections VIII. and IX. of the United States Survey, or between it and the Mexican frontier.

10. NEW ORLEANS.—The longitude of New Orleans is of some interest. The United States Coast Survey assumed a considerable degree of importance from its extent, and these results being extended to the other portions of the territory, rendered the con-

sideration of a *primary* meridian for the western world one necessary to be determined in the early state of the operations.

The Capitol of Washington would naturally appear to be the fittest starting point; but as the introduction of greater diversity in astronomic and other Tables than at present exists is certainly not desirable, the United States Survey Department commissioned Professor Bache to report on the subject. Impressed with the inconvenience attached to the introduction of a fresh mode of reckoning meridional distances, and at the same time to give due importance to the geodetical operations carried on in America quite independent of any in the eastern hemisphere, he recommended, if any transatlantic meridian were to be assumed as a primary, that of *New Orleans* would be the fittest.

The progress of the survey having shown that New Orleans was in long. 90° 0′ 0″, or nearly so, it became manifest that one objection to a new fractional element being introduced was in some degree removed if this were taken. With this view, if any meridian were to be assumed for the United States, that of 90° West of Greenwich, *wherever it may fall*, is the fittest. If in the course of the operations any correction be found necessary to this meridian, as marked in some part of New Orleans, let it be removed accordingly. Thus the first meridian of the United States would be one-fourth of the circumference of the globe, or six hours in time, West of that of Greenwich.

VARIATION OF THE COMPASS.

The question of Magnetic Variation or Declination received much attention from the United States Survey Department, under the superintendence of Professor Bache, who, with Mr. J. E. Hilgard and other officers, have reported on the subject. The amounts given in the Table can only be considered as approximate.

The line of *No Variation* intersects the coast about Charleston. To the north-eastward of this line, the *Westerly* variation is *increasing* about 3⅓′ per annum in the vicinity of Cape Hatteras; about 3¼′ per annum near New York, and on the Coast of Maine.

The lines of *equal* variation run about N.W. and S.E. *true* on the Coast of Maine; N.W. by N. and S.E. by S. about New York; and N.N.W. and S.S.E. on the Coasts of Carolina and Georgia.

16. THE BERMUDA ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Ireland Island, South extr. of breakwater .... [1]	32 19 20	64 51 35		The Trigonometrical Survey, by Captain Thos. Hurd, R.N., between the years 1783 and 1797, adjusted by the observations of Captain Edward Barnett, R.N., 1846, and later observers.
Somerset Island, beacon...	32 17 4	64 53 55		
Gibb's Hill, Lighthouse [2]	32 15 4	64 51 36	8 20	
Castle Island, entrance of Castle Harbour............	32 20 18	64 41 50		
St. David's Head, Lightho.	32 21 42	64 40 40		
Fort Cunningham, entr. of St. George's Harbour ...	32 22 18	64 41 0		
Mills Breaker, eastern edge of the reef	32 24 30	64 39 20		
North Rock, northern side of reef........................	32 28 20	64 47 45		
Challenger Bank, N.E. extremity 24 fathoms	32 7 15	65 4 15		

NOTES.

1. Between the years 1783 and 1797, Captain T. Hurd, R.N., was employed in the survey of these beautiful islands, the outline of which survey was published by the British Admiralty. Captain Hurd deduced his longitudes from Wreck Hill, which may be taken as having been within 4′ or 5′ East of the correct longitude. In the chart of the Bermuda Islands, published by Mr. Laurie, the longitude is deduced from recent observations, but notice was issued, in 1886, that from further investigation the Dockyard Clock Tower at Ireland Island appeared to be in long. 64° 49′ 35″, or about 2′ to the eastward of the position previously accepted. This would affect all the positions here given. Now that telegraphic communication exists with the islands, from Halifax, N.S., the exact longitude will probably be ascertained before long.

WRECK HILL.—Captain Hurd considered this to be in lat. 32° 15′ 20″, long. 64° 50′; but, according to the corrected position of Ireland Island flagstaff, this is 1′ 25″ South, and 4′ 40″ East of its right place.

2. GIBB'S HILL LIGHTHOUSE.—The position of this was obtained by triangulation from Ireland Island. Recent observations, by English and United States Officers, make the longitude to be 64° 50′ 7″ W.

The VARIATION of the COMPASS is *increasing* at Bermuda, at the rate of about 2′ per annum.

17. THE BAHAMA AND PASSAGE ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
LITTLE BAHAMA BANK.				
Matanilla, or Maternillo Bank, N.W. end ...... [1]	27 21 15	79 5 0	1 10	Captain Edward Barnett, R.N., 1846, & later observers.
Outer part of the Western Reef	27 5 0	79 12 0		
Memory Rock	26 56 45	79 6 40		
Settlement Point, W. end of Grand Bahama Island	26 41 30	79 0 35		
Burrow Kay, off S.E. point	26 25 30	77 46 50		
Hole in the Wall, Lightho.	25 51 30	77 11 10	0 40	
Elbow Kay, Lighthouse ...	26 32 10	76 57 0		
Moraine Kay..................	26 2 30	77 46 15		
Walker Kay	27 15 30	78 24 50		
GREAT BAHAMA BANK.				
The Southern Kays, The Jumentos, &c.:				
South Hd., nearly awash	22 2 0	76 23 35		The Observations of Capt. Richard Owen, R.N., 1831—1832, &c.
The Brothers, S.E. rock	22 1 45	75 42 15		
Kay St. Domingo.........	21 41 55	75 46 30		
Kay Verde..................	22 1 15	75 12 0		
Little Ragged Isle, Beacon on South end	22 9 30	75 42 30	1 5	
Ragged Island, Flagstaff	22 11 40	75 44 30		
Racoon Kay, Beacon ...	22 21 50	75 49 39		
Channel Kay, Beacon ...	22 31 5	75 51 30		
Jamaica South Kay......	22 42 56	75 54 46		
Man of War Kay, N. end	22 48 30	75 58 45		
Flamingo Kay, centre...	22 52 45	75 52 6		
Water Kay, S.W. point	22 59 30	75 45 0		
Pear Kay	23 7 30	75 32 15		
Yuma or Long Island:				
South Point	22 50 50	74 52 30	0 25	
Great Harb., Clarence...	23 6 10	74 59 30		
Michael Bank, 12 fms....	23 9 15	74 45 30		
Santa Maria, Whale, or North Point	23 41 37	75 20 0		
Exuma, the Beacon.........	23 31 58	75 46 35		
Galliot Cut, on the bank...	23 54 45	76 15 20		
Eleuthera, S.E. point	24 37 40	76 8 45		
Governor Harbour	25 12 0	76 15 25		
James' Cistern	25 21 0	76 23 0		
Harbour Island, S. end	25 29 0	76 38 30		
Egg Island, Lighthouse	25 30 30	76 54 30		

THE BAHAMA AND PASSAGE ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
The Isles, &c., on N.W.:				The Surveys of Captain Richard Owen, Captain E. Barnett, Lieut. T. Smith, R.N., &c.
Fleeming Chanl., Beacon	25 16 45	76 55 8		
Douglas Channel, Entr.	25 9 15	77 6 0		
Nassau, New Providence, Lighthouse ....[2]	25 5 45	77 21 35	1 5	
Clifton or West Point...	25 1 5	77 34 10		
Joulter Kays, N. extreme	25 19 30	78 8 30		
Andros Isles:				
Morgan's Bluff, or N.E. Point	25 10 24	78 1 30		
High Kay, on the East Coast	24 39 30	77 42 30		
Golding Kay	24 13 40	77 36 30		
Green Kay, West end...	24 2 15	77 11 50		
Berry Isles:				
South Stirrup Kay, N.W. point	25 25 5	77 55 45		
Great Stirrup Kay, Lt.-house	25 49 40	77 53 45		
Holmes Kay, centre ...	25 37 40	77 44 0		
Great Isaac, Lighthouse	26 2 15	79 6 10	1 35	
Western side of the Great Bank:				
Moselle Bank, Bemini Is.	25 49 10	79 17 15		
Gun Kay, Lighthouse ...	25 34 35	79 19 0		
Brown's Kay...............	25 23 40	79 13 0		
S. Riding Rock, Beacon	25 14 0	79 10 0		
Orange Kay, Middle......	24 56 30	79 9 10		
Southern part of the Bank:				
Guincho, or Ginger Kay	22 45 0	78 7 15		
Lobos Kay, Lighthouse	22 22 50	77 36 0		
Mucaras, or Diamond Point..................[3]	22 10 30	77 20 0		
Cayo Verde, or Green Kay........................	22 1 15	75 12 0		
Kay of St. Domingo ...	21 41 55	75 46 30	1 10	
Kay Sal Bank, Elbow Kay, Lighthouse	23 56 0	80 28 0		
Anguila Islands, S.E. pt.	23 29 30	79 32 30		
THE PASSAGE ISLANDS.				
Little San Salvador, West point	24 36 22	75 59 0		
San Salvador, Columbus or S.E. Point...............	24 8 10	75 17 0	0 25	
Hawk's Nest, or S.W. Point	24 8 50	75 33 0		
N.W. Point	24 41 10	75 47 10		
Conception Island, S. end	23 48 55	75 7 20		
Southampton Reef, N. extr.	23 55 30	75 7 30		

THE PASSAGE ISLANDS.

	LAT. N.	LONG. W.	VAR. 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Rum Kay, S.E. White Cliffs	23 38 40	74 47 40		The Surveys of Captain Richard Owen, Captain E. Barnett, Lieut. T. Smith, R.N., &c.
S.W. end .... [4]	23 38 40	74 57 20		
Watling Island; Large			EAST.	
White Rock at N. end	24 10 15	74 28 0	0 10	
S.W. Point..................	23 56 15	74 34 30		
Hinchinbroke S. Rock...	23 56 0	74 28 38		
Samana or Attwood Kays:				
East Low Kay	23 5 10	73 36 30		
Westernmost Reef, extr.	23 5 50	73 51 15		
White Cliff, South side	23 4 45	73 48 45		
Planas or Flat Kays, S.W. end of West Kay	22 34 30	73 37 40		
Crooked Islands, &c.:				
The N.E. Breaker	22 48 0	73 47 0		
Mount Pisgah	22 44 10	74 7 38		
Bird Rock Lighthouse...	22 50 15	74 22 15		
Fortune Isle, or Long Kay, South point	22 32 0	74 28 20		
Castle Isle, Lightho. [5]	22 6 45	74 20 30	0 35	
Miraporvos:				
North Rock	22 7 50	74 38 30		
South Kay, centre	22 5 0	74 38 0		
Hobart's Breakers, S.E. end	21 58 30	74 28 30		
Diana, or Monkey Bank, 9 fathoms	22 30 30	74 48 0		
Mariguana, or Mayaguana, S.W. point...............	22 21 45	73 10 0		
Eastern End of E. Reef	22 18 0	72 38 0		
The Caycos:			WEST.	
Cape Comet, N.E. point	21 42 30	71 27 20	0 20	
Large House near the Booby Rocks	21 50 30	71 42 30		
The Three Maries.........	21 59 0	72 2 0		
Providenciales, N.W. pt.	21 52 0	72 20 8		
West, or Little Cayco, S.W. point...............	21 37 0	72 29 20		
West Sand Spit	21 22 0	72 9 0		
South Shoal	21 2 0	71 44 20		
Swimmer Shoal	21 5 15	71 30 30		
Cockburn Harbour, Parson's Point...............	21 30 0	71 31 0		
The Hogsties, N.W. Kay	21 41 30	73 50 30		
Great Inagua:				
The N.W. Point	21 7 10	73 39 50		
Middle or West Point...	21 1 45	73 42 0		
S.W. Point..................	20 55 0	73 38 40		
Matthew Town, Lt.-ho.	20 56 30	73 40 15		
Lantern Head (82 feet)	20 56 30	73 19 0	EAST.	
S.E. Point..................	20 57 45	73 9 15	0 25	
N.E. Point..................	21 20 45	73 0 45		

THE PASSAGE ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST. 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Little Inagua:				
East Point	21 29 0	72 55 15		The Surveys of Captain Richard Owen, Captain E. Barnett, Lieut. T. Smith, R.N., &c.
N.W. Point	21 30 30	73 4 0		
Turk's Islands:				
Endymion Reef	21 7 15	71 18 40		
Sand Kay, centre	21 11 12	71 14 33		
Salt Kay, centre	21 20 0	71 12 0		
Grand Kay, Hawk's Nest	21 26 15	71 7 30	0 20	
Square Handkerchief, N.E. detached Breaker	21 6 30	70 29 30		
S.E. extremity	20 48 30	70 29 15		
Western extremity	20 55 30	70 59 0		
Silver Kay, or Plate Bank:				
East End (10 fathoms)	20 35 20	69 21 58		The Surveys of Mr. Anthony De Mayne, &c.
S.E. Point	20 15 0	69 35 45		
N.W. Point	20 55 0	69 55 30		
S.W. Point	20 17 20	70 0 0	0 20	
Bajo de Navidad, or Ship Bank:				
Northern Extremity	20 14 0	68 50 30	0 40	
Eastern Extremity	20 2 0	68 46 30		
South Extremity	19 51 30	68 55 30		

NOTES.

1. Matanilla Bank.—Matanilla Bank, to the northward of the reef, was not represented in Mr. De Mayne's Chart, although given in that of the Spanish Surveyors. It was examined by Captain Edward Barnett, R.N., in 1846, and the positions corrected accordingly.

2. Nassau.—The position appears to be finally settled as in the Table. The Spanish Surveyors gave the town as in lat. 25° 4′ 38″ N., long. 77° 19′ 30″ W. Mr. De Mayne as in 25° 5′ 18″ N., 77° 19′ W.

3. Diamond Point of the Mucaras.—The Mucaras, Lavanderas, and Lobos, with the dangers on the bank in the vicinity, were surveyed, with great care, by Captain Edward Barnett. This portion of the bank was formerly represented, as in the Spanish Charts, rather more to the South, and 6′ more to the East.

4. Rum Kay.—This island was formerly very erroneously represented on the charts, both as to magnitude and position. The white cliffs at the S.E. end are remarkable, and may be seen 18 miles off.

5. Castle Isle.—This point appears to be finally settled. Former observations gave lat. 22° 7′ 45″ N., long. 74° 17′ 30″ W.

The Variation of the Compass is *decreasing* among the Bahama Islands, at the rate of about 3¼′ per annum.

18. CUBA, JAMAICA, ETC.

	LAT. N.			LONG. W.			VAR. EAST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
SOUTH COAST OF CUBA.									
Cape Maysi, Lightho. [1]	20	15	10	74	8	40	1	5	**Surveys by officers of the Spanish Navy, with partial Surveys by Captain Richard Owen, R.N., & recent English Surveyors.**
Port Guantanamo, Light on end of mole	20	1	0	75	16	0			
SANTIAGO DE CUBA, Blanca Battery, S. angle [2]	20	0	16	75	50	30	1	45	
Morro Lighthouse	19	57	42	75	54	20			
Cape Cruz, Lighthouse	19	49	40	77	43	48	2	20	
Caballones Channel, Pilot Point	20	46	30	78	58	30			
Boca Grande Kay, West pt.	20	59	0	79	18	0			
River Guaurabo, Ciriales Point	21	46	0	80	2	0			
Port Casilda, Casilda Point	21	40	30	79	58	4			
Port Xagua or Jagua, Lt.-house	22	1	0	80	30	0	2	45	
Xagua Bank, shoal part	20	37	0	80	35	0			
Piedras Kay, Lighthouse	21	59	0	81	3	0			
Jardines Bank, East point	21	39	0	81	2	0			
Rosario Channel, South entrance	21	37	0	81	55	0			
Isle of Pines, Frances Point [3]	21	36	15	83	12	34			
Extreme South point	21	24	0	82	56	0	3	40	
San Felipe Kays, S.W. part	21	55	0	83	30	0			
Laguna de Cortes, small kay at entrance	22	4	0	83	51	0			
NORTH COAST OF CUBA.									
Cape Antonio, Lighthouse	21	51	30	85	1	33	4	15	
Colorados Reef, S.W. end	22	9	0	84	48	0			
Jutias Kay, West end	22	43	20	84	6	30			
Bahia Honda, Point Cerro del Morrillo	22	58	49	83	12	0			
HAVANA, Morro Lt.-ho. [4]	23	9	21	82	21	30	3	15	
Engineer's post under No. 4 fort	23	8	58	82	20	48			
Peak of Matanzas, summit	23	1	54	81	48	15			
Kay Piedras, Lighthouse	23	14	10	81	8	17			
Cruz del Padre Kay, Lt.-ho.	23	16	50	80	54	30			
Sagua La Grande, N. end	22	56	30	79	59	46			
Bahia de Cadiz Kay, Lt.-ho.	23	12	40	80	31	0			
Kay Francés, Lighthouse	22	38	25	79	13	15			
Paredon Grande Kay, Lt.-house	22	29	3	78	9	58	2	0	
Kay Confites, South point	22	11	14	77	40	5			
Kay Verde, N.W. end	22	8	45	77	38	15			
Maternillos Point, Lightho.	21	40	2	77	8	4			
Port Nuevitas, Lighthouse on Barlovento Point	21	37	30	77	4	34			

CUBA, JAMAICA, ETC.

	LAT. N.	LONG. W.	VAR. EAST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Port Padre, Point Guinchos	21 18 0	76 32 45		Surveys by officers of the Spanish Navy, with partial Surveys by Captain Richard Owen, R.N., & recent English Surveyors.
Port Naranjo, East side of entrance	21 7 0	75 52 25		
Peak of Sama, summit (335 feet)	21 5 0	75 50 0		
Port Nipe, Roma Point ...	20 47 0	75 31 45		
Port Sama, East side of entrance	21 9 0	75 47 0		
Lucrecia Point, Lighthouse	21 4 24	75 36 54	1 30	
Port Cayo Moa, Pajaros or South Point	20 41 20	74 53 32		
Port Baracoa, Lighthouse	20 21 40	74 29 0		
JAMAICA, and Isles Adjacent. [5]				
Navassa Island, N.W. extr.	18 24 30	75 3 0	2 0	From the Surveys of Capt. Richard Owen, R.N., 1835, and more recent Surveys.
Morant Kays, N.E. kay ...	17 26 30	75 58 20		
Formigas Bank, shoal spot	18 33 0	75 44 45		
Morant Point, Lighthouse	17 55 5	76 11 50	2 30	
Port Morant, Bowden Pier	17 53 15	76 19 55		
Morant Town Church	17 52 55	76 25 30		
Lamottes Bank (4 fathoms)	17 50 5	76 30 40		
Cow Bay Point	17 52 20	76 37 5		
Plum Point Light	17 55 40	76 47 20		
Port Royal, Fort Charles Flagstaff [6]	17 55 56	76 50 33		United States Officers, 1875.
Kingston, Fort Augusta Lt.	17 58 0	76 51 30		
St. Michael Church	17 58 0	76 47 30		
Portland Bight, Pigeon Id., centre	17 47 40	77 5 0		
Portland Point	17 42 12	77 10 0		
Carlisle Bay, Pier House...	17 46 30	77 17 23		
Round Hill	17 51 30	77 23 0		
Alligator Reef, N.E. end...	17 48 40	77 32 20		
Pedro Bluff, S.W. extreme	17 51 12	77 45 15	2 55	
Black River Anchorage, Church	18 1 25	77 51 55		
Savanna la Mar Fort, ruin	18 12 20	78 8 54		
South Negril Point	18 16 15	78 23 48	3 5	
St. Lucia, Fort	18 27 45	78 11 34		
Montego Bay, Fort	18 29 25	77 56 56		
Falmouth, Fort	18 30 34	77 40 24		
St. Anne Bay, Prison	18 26 24	77 13 50	2 40	
Port Maria, N.W. Wharf...	18 23 0	76 54 54		
Port Antonio, Fort flagstaff	18 11 15	76 27 24		
Manchioneal Harbour, N. entrance point	18 2 15	76 17 10		
Red Cliffs	17 59 30	76 15 20		
Pedro Bank, East end, Portland Rock ... [7]	17 6 20	77 27 15	3 0	
S.W. Breakers	16 48 30	78 12 0		
N.W. edge	17 37 30	78 51 0		

JAMAICA, ETC.

	LAT. N.	LONG. W.	VAR. EAST. 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Baxo Nuevo, Kay	15 51 0	78 38 0		From the Surveys of Capt. Richard Owen, R.N., 1835, and more recent Surveys.
Grand Cayman, Fort George, West end ... [8]	19 17 45	81 23 50	3 45	
Little Cayman, West point	19 39 30	80 7 30		
Cayman Brac, Scott House, near S.W. point.........	19 41 20	79 54 9		
N.E. point..................	19 45 0	79 44 25	3 5	
Pickle Bank, Centre	20 23 20	80 29 50		
Serranilla, S.W. Kay	15 47 45	79 51 27	3 45	

NOTES.

1. Cape Maysi.—Captain Foster placed Cape Maysi in 74° 5′ 18″, considering Chagres as 78° 57′ 19″. Captain Owen made it 74° 8′ 0″.

2. St. Iago de Cuba.—Mr. Nicholls, Master of the *Shearwater* brig of war, in 1819, communicated the situation of the Morro Castle of St. Iago, from observations made in that ship, as follows :—Latitude observed, 19° 57′ 50″; longitude by lunars, 76° 2′ 45; by chronometer, 76° 0′. The Spanish Chart of the harbour represented the Morro as in 75° 55′ 33″ W. Telegraphic determination from Havana, by United States Officers, in 1875, placed the Morro Lighthouse in long. 75° 52′ 6″ W.

3. Cape Antonio, Isle of Pines, &c.—On the 12th of August, 1817, Capt. Livingstone came to an anchor off Cape Antonio, in 7 fathoms; and, by an excellent observation, found his latitude to be 21° 53′ 54″, confirming that given by the Spanish Officers. The longitude was considered as well established between 84° 57′ and 84° 58′. The Baron von Humboldt gave 84° 57′; Captain Owen, 84° 58′; the Spanish Officers had previously given it as 84° 57′ 30″. The position given in the Table accords with that on the most recent charts.

4. Havana and Lighthouse.—The longitudes in the western part of the Caribbean Sea depend upon the position of the Morro Lighthouse, Havana, given by Don José Joaquin de Ferrer, Astro. Soc. Mem. iv., page 586; long. 82° 22′ 12″ W. Note: Telegraphic determination from Washington, United States, by the United States Hydrographic Office in 1875, placed Morro Lighthouse in long. 82° 21′ 28″ W.

The position of the Engineer's post, near the steam wharf under fort No. 4, Havana Harbour, has been deduced from the Morro Lighthouse, and is here given as being convenient for rating chronometers, lat. 23° 8′ 58″ N., long. 82° 20′ 43″ W.

The position formerly given was lat. 23° 8′ 18″ N., long. 82° 22′ 4″ W., the longitude being the mean of twenty results from stars eclipsed by the moon, by Don Josef Joachim de Ferrer, 1809-10-11-12. This place, which was taken by Lieut. Raper as a secondary meridian, was considered by him as in long. 82° 21′ 57″ W. The difference, 17″, between this and Mr. Purdy's position, as given in our previous editions, is but trifling, and the difference between Mr. Purdy's position in 1850 and that determined electrically from Washington in 1875, is but 17″, the latter position placing it in 82° 21′ 28″.

5. JAMAICA in general.—In his "Outline of Jamaica, 1821," Mr. De Mayne gives Morant, or the eastern point, in longitude 76° 12′, and South Negril, or the western point, in 78° 25′ W. Mr. Leard, in his survey of 1791, gave Morant Point in 76° 8′, and South Negril in 78° 33′; consequently, he represented the island more than 15′ longer than it has since been exhibited.

6. **Port Royal.**—Telegraphic determination from Havana, by United States Officers, in 1875, placed the flagstaff at Port Royal in long. 76° 50′ 38″ W. The northern coast, it appears, was placed too far North from 1 to 2 miles.

7. **Portland Rock.**—Portland Rock is a single kay, 14 to 20 feet above the sea, and covered with small bushes. It has been variously represented in from lat. 17° 7½′ to 17° 13′, and from long. 76° 32′ to 77° 31′. In Mr. De Mayne's Chart it appears in 17° 7½′ N., and 77° 29′ W. The position given in our Table cannot, we think, be far from the truth. The Officers of H.M.S. *Winchester*, in 1834, by numerous altitudes, &c., gained the latitude of the rock as 17° 7′ 25″, long. 77° 27′ 4″.

8. **Grand Cayman.**—The latitude of the S.W. kay of the Grand Cayman, as observed by Captain Livingstone, August 5th, 1817, appeared to be 19° 14′, not 19° 11′, the parallel formerly assigned; the longitude was communicated to us by the late Captain Hurd, as a determination to be relied on, and it appears to have been confirmed by Captain J. W. Monteith.

Don J. M. Herrera, of the Spanish Navy, 1863, placed the East extreme of the Eastern Little Cayman (Cayman Brac) in lat. 19° 45′ 15″ N., long. 79° 46′ 24″ E. The S.E. point, according to Mr. Dunsterville, lies in lat. 19° 16′ N., long. 81° 6′ 40″ W.

The Variation of the Compass is *decreasing* around the Coasts of Cuba, Jamaica, &c., at the rate of 2¾′ to 2′ per annum.

19. HAITI OR SANTO DOMINGO, PORTO RICO, AND THE VIRGIN ISLANDS.

	LAT. N.	LONG. W.	VAR. EAST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
HAITI OR SANTO DOMINGO.				
Isle of Mona, West Point	18 4 0	67 56 15	0 0	Spanish Surveys.
Cape Engaño	18 35 51	68 20 0		
Espada Point	18 21 0	68 28 15		
Isle of Saona, West point	18 14 0	68 47 0		
Quiabon River, entrance	18 20 20	68 58 23		
Boca de la Romana	18 22 0	68 56 37		
Macoris	18 25 50	69 10 25		
Santa Catalina Island, W. point	18 19 0	68 59 0		
City of Santo Domingo, Cathedral, W. portal [1]	18 28 17	69 52 26	0 30	
Lighthouse	18 27 54	69 52 59		United States Officers, 1890.
Neiva Bay, River entrance	18 24 0	70 59 0		Capt. Richard Owen, R.N. and Edw. Dunsterville, Esq. R.N., 1826, &c.
Alta-Vela, or the High Sail [2]	17 29 30	71 38 0		
Pta. Ajugas, or False Cape	17 47 0	71 41 0		
Frayle Rocks, South end	17 37 0	71 41 0		
Cape Jacquemel, or Jacmel	18 11 20	72 35 15	1 20	
Jacmel, Wharf	18 13 30	72 33 39		

HAITI OR SANTO DOMINGO.

	LAT. N.			LONG. W.			VAR. EAST, 1895.		AUTHORITIES.
	°	'	"	°	'	"	°	'	
Aquin Bay, Grosse Kay, centre	18	13	30	73	23	0			Capt. Richard Owen, R.N., and Edw. Dunsterville, Esq., R.N., 1826, &c.
St. Louis, the Fort	18	14	37	73	34	30			
Aux Cayes, the Town Mole	18	11	18	73	46	15			
Isle à Vache, East point	18	4	0	73	35	25			
Point Abacou	18	2	40	73	47	30			
Pointe à Gravois	18	2	20	73	57	0			
Cape Tiburon, extremity	18	22	0	74	29	30	1	50	
Irois Bay, House on the Beach	18	23	48	74	29	33			
Isle of Navaza, middle	18	25	45	75	3	0			
Cape Dame Marie, or Donna Maria	18	37	30	74	27	31			Staff-Comm. Kiddle, R.N., 1873.
Jérémie Bay, Wharf	18	38	0	74	5	45			
Miragoane Harbour, Town	18	28	0	73	4	30			
Pirogues, on Rochelois Reef	18	38	30	73	12	20			
Hummock of Petit Gonave	18	41	30	72	48	10			
Isle of Gonave, West point	18	55	26	73	18	30			
Port Au Prince, Fort Alexander	18	33	10	72	19	46	1	15	
Arcadins, northernmost	18	48	0	72	38	0			
St. Marc, or St. Mark's Pt.	19	2	10	72	50	0			
Port Piment	19	36	30	72	57	0			
Cape Foux	19	44	0	73	27	15			
St. Nicolas Mole, Fort George flagstaff	19	49	15	73	23	7			United States Officers, 1889.
Port à l'Ecu, West Point	19	55	10	73	4	30			
Port Paix, Carenage Point	19	57	30	72	48	45			
Tortue or Tortuga Isle, West Point	20	3	0	72	57	0			
East Point	20	1	30	72	35	0			
City of Cape Haytien, Watering Place	19	46	40	72	10	42	0	5	
Manzanillo Bay, Manzanillo Point	19	45	34	71	47	20			
Granja Point	19	53	40	71	40	45			U.S.S. *Congress*, 1871.
Cape Isabella	19	56	0	70	58	0			
Isabella Bay, Islet	19	53	50	71	4	7			
Port Plata, Lighthouse on East Point	19	48	51	70	41	27			United States Officers, 1889.
Old Cape Français	19	40	0	69	54	15			
Cape Cabron	19	21	30	69	11	30			
Cape Samana	19	19	0	69	6	15			
Samana Bay, Balandra or North Point	19	11	10	69	13	30			United States Survey, 1883.
Port Santa Barbara, Castillo Point	19	12	30	69	19	24			
Cape Raphael	19	3	0	68	51	30			Spanish Surveys, especially those of Captains Don Cosmé de Churruca, Francisco Fidalgo, Juan Romero, &c.
Punta Macao, ranchos	18	50	0	68	35	0			
Cape Engaño, extreme	18	35	51	68	20	0	0	0	

PORTO RICO—THE VIRGIN ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
ISLAND OF PORTO RICO.				
Cape St. Juan, or N.E. Pt.	18 23 15	65 36 45	0 40	Spanish Surveys.
MORRO CASTLE OF ST. JUAN, Lighthouse ... [8]	18 28 56	66 7 23		United States Officers, 1875.
Point Bruguen, or N.W. Point, Lighthouse	18 29 0	67 7 30	0 15	
Desecheo Isle, North end	18 23 48	67 30 0		
Aguadilla Town .... [4]	18 25 20	67 11 0		
Mayaguez Bay, Algarrobo Point	18 14 22	67 12 0		French Survey.
Mayaguez River, N. point of entrance	18 11 56	67 9 4		Lieut. Sharrer, U.S.N., 1886.
Aguila Point, S.W. point...	17 58 0	67 15 0		
Port Ponce, Custom House	17 58 51	66 39 30		Lieut. G. H. Stoate, R.N., 1875.
Puerto Guanica, East Point	17 57 44	66 58 0		
Caxa de Muertos, or Coffin, Lighthouse on summit	17 53 0	66 34 0	0 25	
THE VIRGIN ISLANDS.				
Anegada, West Point	18 45 15	64 24 50	1 20	The Survey by Lieutenant G. B. Lawrence, R.N., and J. Parsons, R.N., 1848-52.
East Point .... [5]	18 42 15	64 16 0		
Soldier, or North Point	18 45 45	64 20 10		
Horse-shoe Reef, S.E. end	18 36 30	64 10 40		
Herman Reef, 9 ft., S. end	18 33 30	64 14 0		
Virgin Gorda, Pajaros or East Point..................	18 30 42	64 18 30		
Ginger Isle, centre	18 23 45	64 28 15		
Tortola, Road Town, Fort Burt	18 25 4	64 36 35		
St. John's, S.E. Point......	18 18 10	64 41 45		
Sta. Monica Rock (9 feet)	18 18 15	64 37 45		
ST. THOMAS HARBOUR, Ft. Christian, S.W. angle [6]	18 20 28	64 55 53	1 0	United States Officers, 1875.
Bergantin, Carvel, or Sail Rock	18 17 15	65 6 0		
Culebra Island, N.W. point	18 21 15	65 20 40		
Vieque or Crab Island, East point	18 8 15	65 16 10		
Port Mula	18 9 15	65 26 30		
Sandy or N.W. Point ...	18 7 20	65 34 50		
ST. CROIX or SANTA CRUZ:				
Eastern extremity of the Island	17 45 30	64 33 40		
SIR ANDREW LANG'S OBSERVATORY ...... [7]	17 44 43	64 41 17		United States Officers, 1875.
Harbour of Christianstæd, Outer Point Battery, or Fort Louisa Augusta, flagstaff......	17 45 28	64 41 32	1 0	

THE VIRGIN ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
St. Croix or Santa Cruz:				
Salt River Point	17 47 12	64 44 45		Survey by Lieut. Lawrence, &c.
Hams or N.W. Bluff ...	17 46 24	64 52 3		
Fort at Frederikstsed or West end, Flagstaff...	17 43 10	64 52 58		
Sandy Point, the S.W. extremity of the island	17 40 40	64 53 48		
Buck Isle, E. extremity	17 47 18	64 36 40		
Summit, about 350 feet	17 47 15	64 37 3		

NOTES.

The United States Government has of late years despatched several officers of its navy to make accurate observations as to the positions of many points of the West Indies and Central America, and the results are given in these Tables, the longitudes having been settled by means of telegraphic signals.

1. Santo Domingo.—We previously gave the longitude of the City as 69° 53′, on the authority of the Spanish Officers, Captains Don. L. Argedas and J. A. Sartorio, who observed an eclipse here in 1780, with a subsequent correction of 1¼′. This result was considered by the talented and energetic Sir Robert H. Schomburgk, F.R.G.S., on his appointment to the Dominican Consulate, in 1849, to be too far West, and he accordingly made many observations, and collected others of authenticity, and placed it as stated in the Table.

2. Alta Vela, or the High Sail.—This is a high rocky islet, which serves as a general point of departure to all ships bound from the eastward to Jamaica, &c. It is peaked, and appears to the northward, at a distance, like a dome, emerging above a mist or fog.

On the authority of the respected and scientific Admiral Espiñosa, of the Spanish Navy, we formerly gave Alta Vela in long. 71° 22′ W., instead of a more westerly position, which had previously been assigned; but it is now fully proved that this is wrong, and that the true longitude is about 71° 38′. Mr. Dunsterville, from the mean of observations in 1826 and 1829, made it 71° 39′ 25″ W. Captain R. Owen made the summit in 71° 39′ 44″ W.

3. Morro of St. Juan.—The Harbour of St. Juan was surveyed by Don Cosmé de Churruca, in 1794. Don Josef Cerquero, Director of the Royal Observatory in the Isle of Leon, near Cadiz, gave the position of the Morro Castle as lat. 18° 29′ 0″, long. 66° 7′ 0″ W., the longitude being considered as one of the best established in America. The position given in the Table is that established by United States Officers in 1875.

4. Aguadilla.—The situation of Aguadilla, as given by the Spanish Officers, is lat. 18° 25′ 53″ N., long. 67° 6′ 20″ W. Admiral Mackellar gave it as lat. 18° 24′ 57″ N., long. 67° 8′ 25″ W. On the latest charts, its situation is as given in the Table.

5. Anegada, with its reef, were surveyed by Mr. (afterwards Sir) Robert Herman Schomburgk, the distinguished traveller, in 1832. He noticed that, between 1811 and 1832, twenty-one American vessels, seventeen West Indian, fifteen Spanish, nine British, two French, two Swedish, and one Portuguese, were wrecked here; and this is attributed chiefly to the insensible operation of the currents.

6. St. Thomas.—With regard to the position of Fort Christian, we received the following communication from Major Sir Andrew Lang:—"The bearings of the flagstaff of *Cowell's Battery*, from my observatory (see note 7), N. 21° 54′ 27″ W., from the true meridian, were determined by myself with a Troughton's altitude, azimuth, and transit circle. Notwithstanding the distance (37½ miles), the flagstaff was distinctly seen with the telescope of the circle, and intersected with the vertical wire. Considering the latitude of the flagstaff, 18° 19′ 32″ N., which must be near it, then its longitude is as stated, 64° 55′ 45″ W., as deduced from my position; but I now strongly suspect that it is a little more to the North, say in 18° 19′ 45″; if so, its longitude, as deduced from my station, will be 64° 55′ 50″ W., and the latitude and longitude of Fort Christian would, on the same data, be lat. 18° 20′ 39″ N., long. 64° 55′ 39″ W. Fort Cowell is on the very top of an eminence (275 ft. above the level of the sea) which rises at the southern extremity of a tongue of land, forming the western side of the entrance, and also the western shore of St. Thomas Harbour." Sir Andrew Lang's observations, therefore, show a very close approximation to the most recent examinations, the results of which are given in the Table.

7. Observatory of Sir Andrew Lang.—"The height of the Observatory, which is about 1 mile to the E.S.E. of the town of Christiansted, is 440 English feet above the sea. The latitude is true to within one second. The longitude is the result, I may say, of the labour of years, and the present assumption of 64° 41′ 0″ in arc, or $4^h\ 18^m\ 44^s$ in time, West from Greenwich, I consider to be determined with almost such absolute certainty, that I do not think the error in the determination can exceed four seconds in time, or one minute in arc, and I trust less. On that datum the longitudes of the other stations are accurately determined. All the latitudes are certain to one or two seconds." —*Andrew Lang.*

Later determinations, with the aid of telegraphy and more perfect instruments, have tended to show the accuracy of Sir Andrew Lang's observations.

The Variation of the Compass is *decreasing* around the Coasts of Haiti, and *increasing* around those of Porto Rico and the Virgin Islands, at the rate of about 2′ per annum.

20. THE CARIBBEE AND LEEWARD ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST. 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Caribbee Islands. [1]				
Sombrero, Lighthouse ...	18 35 40	63 27 55	2 0	Captain E. Barnett, R.N., Lieut. E. Lawrence, R.N., Mr. Parsons, R.N., &c.
Dog Isle, landing on S. side	18 16 15	63 16 10		
Anguilla, Custom House on North side	18 13 6	63 4 40		
Scrub Island, East point...	18 17 30	62 55 40		
St. Martin's; Philipsburgh, Stadt House	18 1 22	63 3 36		
West Point	18 3 25	63 10 0		
Saba, the centre	17 38 0	63 14 0		
St. Bartholomew, Gustaf Harbour, Fort Oscar ...	17 53 58	62 51 31		
Barbuda, Martello Tower on S.W. side	17 35 50	61 49 36	2 20	

THE CARIBBEE AND LEEWARD ISLANDS.

	LAT. N.			LONG. W.			VAR. WEST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
St. Eustatius, Orange Town, Fort	17	29	20	62	58	50			Captain E. Barnett, R.N.,
St. Christopher's, Basse-Terre, Church ...... [2]	17	18	10	62	42	50	1	45	Lieut. E. Lawrance, R.N., Mr. Parsons, R.N., &c.
Nevis, Charlestown, Fort	17	7	50	62	37	10			
Redonda, the Pinnacle, 600 feet	16	56	0	63	19	0			
Montserrat; Plymouth, Wharf	16	42	12	62	13	0			
ANTIGUA; St. John's Road, Fort James	17	6	40	61	51	45			
North Tower of Cathedral	17	6	12	61	50	28			United States Officers, 1875-6.
Fort Byham, on N.E. side	17	7	10	61	46	42			
Dockyard Flagstaff, English Harbour	17	0	0	61	45	42	2	20	
Desirade or Deseada, N.E. point .... [3]	16	20	50	61	0	10			
Guadaloupe, Basse-Terre, Fort	15	59	20	61	43	5	1	40	French Surveys.
St. Anne, Church	16	13	30	61	22	40			
Port du Moule, Lightho.	16	20	0	61	20	10			
Pointe à Pitre, Jarry Mill	16	13	56	61	32	34			
Grand Vigie or N. Point	16	31	0	61	27	30			
Marie-Galante, Grand Bourg Light	15	53	0	61	18	35			
The Saintes; St. Paul, Bolt Head, S.W. Point	15	50	55	61	38	35			
Aves Islet	15	42	0	63	37	45			Lieutenant Lawrance.
Dominica, Road of Roseau, Fort Young......... [4]	15	17	27	61	23	32			
Cape Melville, N.W. pt.	15	38	20	61	28	5			
Prince Rupert Bay, Roman Catholic Ch.	15	34	37	61	27	54			
Scots Head, S.W. point	15	12	30	61	22	45			
Martinique, Fort Royal or de France, Fort Louis [5]	14	36	7	61	4	30	1	20	French Surveys.
Caravelle Peninsula, Lt.-house	14	46	10	60	52	55			
ST. PIERRE, Upper Light in Ste. Marthe Battery	14	43	54	61	11	12			United States Officers, 1875.
St. Lucia, Pt. Moulacique or South Pt., S.E. end	13	43	0	60	56	50			
Port Castries, Bananes Point	14	0	58	61	0	25			
St. Vincent, Kingston Ch.	13	9	15	61	13	24	0	45	
Grenadines, Bequia, Admiralty Bay, Church	13	0	25	61	13	58			

THE CARIBBEE AND LEEWARD ISLANDS.

	LAT. N.	LONG. W.	VAR. 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Barbados; Bridgetown, Fort Beckwith ... [6]	13 4 53	59 36 18	WEST. 1 15	Harris and Stanley, 1869.
RICKETT'S BATTERY, Flagstaff..................	13 5 43	59 37 18		United States Officers, 1875.
North Point	13 20 10	59 36 24		
South Point, Lighthouse	13 2 57	59 31 24		
Diamond Islet	12 19 40	61 34 45		
Grenada, Fort St. George [7]	12 3 2	61 44 55		
Tobago, N.E. Point ... [8]	11 20 59	60 31 6	0 20	Mr. J. Parsons, R.N., 1864-5.
Scarborough Landing Wharf.....................	11 10 55	60 43 35		
Crown Point, S.W. end	11 8 35	60 49 55		
Trinidad:				
Point Galera, N.E. point	10 50 2	60 54 5	0 5	Commander W. Chimmo, R.N., 1866-8.
Point Galeota, S.E. point	10 8 25	60 59 30		
Siparia Hill, 400 feet, centre.....................	10 5 30	61 28 0		
Icacos, or S.W. Point...	10 3 20	61 55 45		
San Fernando Pier Head	10 16 59	61 28 10		
Cipero River, entrance	10 15 50	61 28 30		
PORT SPAIN, Water Battery Flagstaff...... [9]	10 38 39	61 30 33	EAST. 0 10	United States Officers, 1875.
Entrada, or N.W. Point	10 42 22	61 40 15		
Chute d'Eau Id., centre	10 45 35	61 30 45		
Chacachacare Id., outer rocks off S.W. point...	10 40 0	62 46 20		
Goose Island, East end ...	10 38 20	61 51 20		The Spanish Surveys of the Coasts of Venezuela, &c., by Don Joaquin Francisco Fidalgo, and other Spanish Officers. Published by the *Direccion Hidrografico*, at Madrid, in 1816 and 1817, corrected by later observations.
Testigos, Centre	11 22 45	63 8 0		
Margarita:				
Pampatar Castle	10 59 0	63 49 25	0 35	
North Point	11 10 5	63 54 30		
San Juan Griego Bay, Maria Libre Point......	11 4 5	64 2 30		
Pta. de Arenas, or Sandy Point	10 58 20	64 26 15		
Blanquilla, North point ...	11 54 30	64 37 30		
Tortuga, East point.........	10 54 45	65 12 10		
Orchilla, N.E. Breakers ...	11 52 45	66 4 30	0 50	
El Roque, Lighthouse......	11 58 15	66 39 30		
Islas de Aves (*Birds Isles*):				
Windward Isle	11 57 30	67 27 30	1 10	
Leeward Isle...............	11 59 30	67 42 0		
Buen-Ayre, N.E. point ...	12 13 30	68 14 30		
South Point, Light	12 2 30	68 17 20		
Curaçao, North point	12 21 0	69 11 30	1 35	
Bay of St. Anna, Rif Fort, Light ...... [10]	12 6 24	68 57 6		Dutch Survey, 1889.
Little Curaçao, Light	12 2 0	68 39 0		
Oruba, S.E. point, Light...	12 28 30	69 55 45	1 40	
North Point	12 36 0	70 8 0		

NOTES.

1. **Windward and Leeward Islands.**—Under the denomination of *Windward Islands*, the navigators of France and Spain include the whole range from the Virgins to Trinidad; and, under that of Leeward Islands, the range which lies between Trinidad and the Gulf of Maracaybo. This distinction is natural and proper, and we have adopted it, in preference to the former distinction in the English charts, which include, under the name of Leeward Islands, those from Porto Rico to Dominica; and, under that of Windward Islands, those from Martinique to Tobago.

The observations of the Spanish officers for determining the respective situations of the Caribbee Islands were very numerous and important, and our charts have been regulated chiefly thereby. Later corrections have, however, been made.

2. **St. Christopher's.**—In January, 1782, the Marquis de Chabert took nine meridian altitudes, whence he concluded the latitude to be nearly as in the Table. The longitude by his marine clocks, previously examined at Martinique, appeared as 62° 52′ 30″. Mr. Zahrtmann made the difference of longitude between it and St. Thomas's 2° 13′ 27″, placing it in 62° 42′ 18″, nearly as in the Table.

3. **Desirade.**—The Chevalier de Borda computed the latitude of the N.E. point as 16° 20′ 30″. Captain Monteith, in lat. 16° 58′, by three observations; longitude of ship by chronometer, 61° 9′ 45″; by lunars, 61° 14′ 38″; mean, 61° 12′ 12″; the bearing of Desirade was S. 5° E., distance 36 miles, which gives 3′ of departure—long. 3′ 5″. Hence longitude of the centre of Desirade, 61° 9′ 7″, about 3′ too far West.

4. **Roseau.**—The latitude of this place, according to the result of observations by Messrs. Verdun, &c., is 15° 18′ 23″. French officers have given the longitude to the westward of that shown in the Table, but the latter is probably correct.

5. **Martinique.**—The latitude accords with that resulting from the observations of Messrs. Verdun, Borda, &c., who concluded the longitude as 61° 0′. Captain Dunsterville gave the longitude of Diamond Rock as 61° 6′.

In the Survey of Martinique, executed by order of the French Government in 1824 and 1825, the longitude of the flagstaff of Fort St. Louis, on which all the other longitudes depend, was assumed by M. Monnier as 61° 1′ 25″. This was arrived at by measurements from Rio Janeiro, &c., and is 3′ less than that now given.

The longitude in the Table is that given by the latest French surveys, and is only 3″ to the eastward of a mean of chronometric measurements by M. Zahrtmann and M. Lartique, between this and the Observatories of St. Croix and St. Thomas.

6. **Barbados.**—The late Dr. Nevil Maskelyne communicated the latitude of St. Michael's Church, in Bridgetown, as 13° 5′ 30″. The longitude was afterwards given as 59° 58′ 40″ and 59° 41′ 15″. From four separate measurements, the meridional difference between Port Royal and Barbados appeared to be 17° 30′ 10″, which would give 59° 20′ 28″ as the longitude of Barbados. In 1850, Lieutenant G. B. Lawrence, by a careful measurement from St. Thomas, with seventeen chronometers, made Fort Beckwith in longitude 59° 36′ 45·6″ W., a close approximation to that given in the Table.

7. **Grenada.**—In 1779, M. de Chabert concluded the latitude of Fort St. George as 12° 2′ 54″, and its longitude 42¼′ West of Fort Royal, Martinique. This varies only 2′ from the statement in the Table. Captain G. Daniell, of H.M.S. *Victor*, in 1838, made the longitude 61° 48′ 30″. It was surveyed by Mr. James Young.

8. **Tobago.**—This island was very doubtfully placed on the charts previous to the survey by Mr. J. Parsons, R.N., assisted by Messrs. J. P. Dillon and W. B. Calver, in 1864-5. The positions given by these officers are those stated in the Table.

9. **Port Spain in Trinidad.**—Captain Foster made Fort St. David at Port Spain, $0^h\ 52^m\ 0{\cdot}8^s$ West of Parà, which telegraphic observations place in 48° 30′ 0″ (South Atlantic Directory, page 9), therefore this would make it in 61° 30′ 12″. M. Zahrtmann stated it to be 3° 10′ 12″ East of St. Croix—61° 30′ 48″. Captain Owen made it 15° 19′ 0″ East of Port Royal, or 61° 31′ 45″. The longitude, according to Lieutenant Lawrance,

is 61° 31′ 0″, and these accord very closely with the position assigned to it by Captain Chimmo, and with the telegraphic determination by United States Officers in 1875.

Captain (afterwards General Sir Edward) Sabine, R.A., from a great number of observations, gave the position of the Protestant Church in Port Spain as lat. 10° 38′ 56″ N., long. 61° 35′ 0″ W.

10. Curaçao.—Till recent years the true position has been doubtful, and even now capable authorities differ. The position of the Rif Fort, as given in the Table, is from the latest Dutch Chart, but careful observations by United States Officers, in 1890, place it in long. 68° 56′ 27″ W.

The Variation of the Compass is *increasing* among the Caribbee and Leeward Islands, at the rate of 3½′ per annum.

21. THE COASTS OF GUIANA, ETC., TO THE MEXICAN SEA, INCLUSIVE.

	LAT. N.	LONG. W.	VAR. WEST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Cape North, extreme	1 40 0	49 56 30	3 30	M. Montravel, Sir R. Schomburgk, Captain Mouchez, of the French Navy, and others.
Mount Mayé, summit	2 46 30	50 54 45		
Cape Cachipour, extreme	3 48 30	51 1 30		
River Oyapok, Cape Orange	4 20 0	51 28 0		
Mount d'Argent, summit	4 20 30	51 39 30		
Grand Connétable, centre	4 49 30	51 55 40		
Cayenne, Jetty Light [1]	4 56 10	52 20 15	2 35	French Survey.
Salut Isles, Lighthouse ...	5 16 50	52 34 56		
Mont Diable, summit	5 10 30	52 54 0		
Sinmarari River, Joubert or West Point	5 21 15	52 54 16		
River Maroni, Française Point, Light......... [2]	5 44 0	53 58 0	1 55	French Survey.
Kaimar Head, W. point of entrance, Light ...	5 43 48	54 0 30		
Orange Creek, village of La Paix........................	5 51 30	54 35 0		
Surinam, beacon on Bram Point	5 58 0	55 10 0	1 15	
Paramaribo, Church	5 50 0	55 14 30		
Coppename or Saramacca River, E. point of entr.	5 54 0	55 55 30		
Corentyn River, New Rotterdam, Nickerie Battery	5 58 20	57 0 30		Dutch Survey, 1888.
Berbicé River, Lightvessel	6 29 0	57 23 30		
New Amsterdam	6 17 0	57 30 0		
Demerara, Lighthouse ...	6 49 20	58 9 47	1 20	English Survey, 1887.
Mocomoco Point, extreme	8 40 0	60 11 0		
Orinoco River, Barima Point, extreme	8 37 30	60 22 0	0 0	
Ciudad Bolivar, market-place	8 8 52	63 32 58		
Baja Point..........................	9 32 0	61 0 0		
Trinidad. *See page* 90.				

THE COASTS OF VENEZUELA AND NEW GRANADA.

	LAT. N.	LONG. W.	VAR. EAST, 1895.	AUTHORITIES.
VENEZUELA. [3]	° ′ ″	° ′ ″	° ′	
Peñas Point, extreme	10 43 48	61 50 50	0 5	The Spanish Surveys of the Coasts of Venezuela, &c., by Don Joaquin Francisco Fidalgo, and other Spanish Officers. Published by the *Direccion Hidrografica*, at Madrid, 1816-1817, corrected by later observations.
Cape Tres Puntas, extreme	10 45 30	62 41 30		
Puerto Santo Islet, centre	10 44 0	63 10 15		
Carupano, Lighthouse......	10 39 30	63 15 0		
Esmeralda Islet, centre ...	10 40 0	63 31 55	0 25	
Morro de Chacopata, extr.	10 42 0	63 50 0		
Escarseo Point, extreme...	10 40 0	64 16 45		
Margarita Island, Ballena Point (see page 90) ...	10 58 55	63 48 0		
Arenas Point, West extr.	10 58 20	64 26 15		NOTE.—Vessels should proceed with great caution between Margarita Island and the main. At night, anchorage will be found under Coche Island.
Sola Island, centre	11 19 30	63 36 0		
Cumana, San Antonio Castle	10 28 0	64 12 0		
Barcelona, Morro Hill......	10 13 30	64 44 0	0 45	
Cape Codera, Morro	10 35 0	66 7 30		
Tortuga Island, Oriental Point	10 55 0	65 12 35		
Centinella Islet, centre ...	10 49 30	66 9 0		
La Guayra, Lightho. near Breakwater	10 36 57	66 56 6	1 10	United States Officers, 1890.
La Silla de Caracas, summit (8,500 feet)..................	10 32 30	66 50 55		
Puerto Cabello, N.W. Bastion	10 29 19	68 0 22		
Tucacas Island, Ore House	10 47 0	68 19 55		
St. Juan Bay, Kay	11 10 0	68 22 55		United States Officers.
Punta Zamuro	11 26 0	68 55 0		
Cape San Roman, extreme	12 11 0	70 4 55		
Maracaybo Bar, Zapara Castle	11 1 0	71 38 0	2 30	
Espada Point, extreme ...	12 3 30	71 7 55		
Los Monges, North Islet...	12 28 30	70 57 0		
OFF-LYING IDS. *See page* 90.				
NEW GRANADA.				
Gallinas Point, extreme ...	12 25 0	71 39 30	2 15	
Bahia Honda, East point...	12 20 0	71 45 57		United States Officers.
Cape Vela, Islet	12 10 0	72 12 55		
La Hacha, Church	11 33 0	72 58 35		
Santa Marta, ruined fort...	11 15 12	74 13 36	3 15	United States Officers.
Tribune Shoal, 3 feet	12 11 0	74 26 0		
Savanilla Harbour, Lt.-ho.	11 0 15	74 57 36		
Morro Hermoso	10 58 0	75 0 15		NOTE.—MORRO HERMOSO is a hill which constitutes a useful landfall westward of the Magdalena.
Zamba Island, Galera Pt.	10 47 15	75 25 30		
Cartagena, Fort Pastelillo	10 24 57	75 33 18	3 50	
Baru Island, Fort San José........................	10 18 58	75 35 19		
Port Cispata, Zapote Point	9 24 0	75 47 30		
Fuerte Island, North extr.	9 24 0	76 10 30		
Caribana Point, extreme...	8 37 30	76 52 55		
Cape Tiburon, extreme ...	8 41 30	77 22 30	4 35	

NEW GRANADA, COSTA RICA, AND MOSQUITO.

	LAT. N.			LONG. W.			VAR. EAST, 1895.		AUTHORITIES.
	°	′	″	°	′	″	°	′	
Port Carreto, peak	8	47	0	77	33	30			Spanish Surveys, &c.
Caledonia Harbour, Scorpion Kay	8	54	52	77	42	25			
Point San Blas	9	35	0	78	58	0			
Manzanillo Point, extreme	9	39	0	79	31	30			
Porto Bello, Fort St. Jeronymo	9	32	30	79	38	30			
Aspinwall, Lighthouse	9	22	9	79	54	45			United States Officers, 1875.
Toro Point, extreme	9	22	45	79	56	0			
Chagres, Flagstaff	9	19	39	79	59	33	5	0	
Escudo de Veragua, West point of island	9	6	30	81	32	30			
Valiente Peak, summit (722 feet)	9	10	30	81	55	35			
Cobbler Rock, centre	9	14	30	82	8	24			
Shepherd Harbour, hut on summit	9	14	22	82	21	7			
Columbus Island, Lime Pt.	9	24	47	82	21	4			
Tirby Point, extreme	9	25	45	82	21	20			
Costa Rica and Mosquito.									
Carreta Point, extreme	9	33	30	82	39	40	5	30	
Blanco Peak, sum. (11,740 feet)	9	16	30	83	4	0			
Port Limon, landing-place	10	0	0	83	3	18			U.S.S. *Kansas*, 1872.
Blanca Point, Grape Kay, Light	10	0	0	83	2	30			
Mount Cartago, the peak, (11,100 feet)	10	1	30	83	48	0			
San Juan de Nicaragua or Greytown, Church	10	55	14	83	42	18	5	25	U.S.S. *Kansas*.
Blewfield, Schooner Point	11	59	0	83	41	30			Owen.
Cookra Hill, summit	12	15	30	83	46	30			
Pearl Kay Lagoon, Mosquito Point	12	20	39	83	37	46			Barnett.
Pearl Kays, Columbilla Kay	12	22	35	83	23	44			
Great Corn Island, Wells North of Quin Bluff	12	9	17	83	4	9	5	5	Owen.
Little Corn Island, Gun Pt.	12	17	30	82	59	9			
Brangman's Bluff, extreme	14	3	0	83	22	0			
Mosquito Kays, South end	14	21	12	82	46	30			
Cape Gracias à Dios, extr.	14	59	40	83	11	0			
Half-moon Kay, centre	15	8	50	82	43	42	4	40	
Gorda Bank, Gorda Kay	15	52	0	82	24	0			
Farrall Rock, centre	15	51	0	82	18	40			
Caxones or Hobbies, Great Hobby	16	3	30	83	8	54			
West end	16	6	0	83	19	0			
Caratasca Lagoon, E. side of entrance	15	23	40	83	43	10			
Bajo Nuevo, Low Kay	15	52	28	78	33	45			

Remarks.

The whole of the coasts of the Bay of Honduras, from Cape Gracias à Dios to Cape Catoche, including the Isles and Shoals between the Pedro Bank and Costa Rica, were surveyed under the able direction of Capt. Owen, Lieut. (after Capt.) Bird Allen,

THE COASTS OF COSTA RICA, HONDURAS, ETC.

	LAT. N.	LONG. W.	VAR. EAST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Roncador Kay, S. point...	13 34 30	80 5 39	3 50	Captain Owen, &c.
Albuquerque Bank, South Kay...	12 10 0	81 50 28		Lieut. (after Admiral) Edward Barnett, Lieut. J. Cannon, and other skilful officers of the British Navy. These important surveys were the means of correcting enormous errors in the representation of the Gulf of Honduras, and they also give a true representation of the Rio and Golfo Dulce, the coasts of which were never before explored.
Courtown Kays, Middle Kay...	12 24 0	81 28 27		
St. Andrew Island, S.W. Cove, Entrance Island...	12 31 40	81 43 40		
Old Providence, Isabel House...	13 22 54	81 22 30	4 50	
Quito Sueno Bank, Spit at N.W. end...	14 30 0	81 7 54		
South extreme of reef...	14 7 30	81 9 54		
Serrana Bank, South Channel, Little Kay...	14 21 30	80 15 20		Barnett.
Serranilla Bank, Beacon Kay...	15 47 45	79 51 27		Owen.
Rosalind Bank, N.W. extr.	16 54 0	80 52 0		
Swan Islands, West one, N.W. point...	17 24 30	83 57 0	4 50	
Honduras and Off-lying Islands.				
River Patook, East side of entrance...	15 48 30	84 17 44	5 0	
Bonacca Island, S. side, Kay next eastward of Half-moon Kay...	16 26 45	85 52 45		
Roatan, Port Royal, N.W. point of George Kay...	16 24 20	86 19 14		
Coxen Kay, centre...	16 18 0	86 35 0		
Truxillo Bay, Cape Honduras...	16 1 15	86 3 15		
Hog Isles, W., highest hill	15 58 0	86 32 48		
Utilla Island, South Kay...	16 3 40	86 59 49	5 35	
Cape Triunfo, Bluff Point	15 48 45	87 28 20		
Congrehoy Peak, summit (3,040 feet)...	15 38 0	86 55 30		
Cape Three Points, N.W. extreme...	15 57 45	88 39 24	6 0	
Gulf of Dulce, Isabel...	15 24 20	89 10 17		
Glovers Reef, S.W. kay...	16 42 10	87 50 45		
N.E. extreme...	16 54 30	87 44 13		
Half-moon Kay, Lightho.	17 12 20	87 32 48		
Lighthouse Reef, Lightho.	17 28 20	87 27 30		
Kay Bokel, centre...	17 8 50	87 56 24		
Mauger Kay, N.W. end...	17 36 30	87 47 10		
English Kay, Flagstaff...	17 19 30	88 3 54	5 45	
Belize, Fort George...	17 29 20	88 11 58		
Forth Standing Creek, ent.	16 57 40	88 14 10		
Cockscomb Mountain, summit (4,000 ft.)...	16 48 10	88 38 13		
Sittee Point, Kay...	16 47 30	88 15 48		
Placentia Point, huts on pt.	16 30 54	88 23 15		
St. George's Kay, centre...	17 33 15	88 5 18		

THE COASTS OF YUCATAN, MEXICO, ETC.

	LAT. N.	LONG. W.	VAR. EAST, 1895.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
YUCATAN AND GULF OF MEXICO.				
Chinchorro Bank, North Kay, North end.........	18 45 0	87 19 15	5 30	Commander E. Barnett, 1839; and others.
Sand Bore, South end...	18 23 20	87 23 41		
Ascension Bay, Allen Point	19 46 55	87 29 1		
Cozumel Island, N. Point	20 35 30	86 44 48	5 15	
Mugeres Harbour, Look-out Tower	21 12 0	86 43 39		
Cape Catoche, N.E. extr.	21 36 0	87 5 15	5 25	
Lagartos, Village............	21 36 0	88 11 0		
Silan, Village..................	21 23 0	88 55 0		
Progreso, Light...............	21 17 0	89 39 15		
Sisal, Fort.....................	21 10 6	90 3 11		
Madagascar Reef, centre...	21 26 30	90 19 0		
Alacran Reef, Perez Kay...	22 23 36	89 43 0	6 10	
Kay Arenas, N.W. kay ...	22 7 10	91 24 54		
Bajo Nuevo Reef, centre...	21 50 20	92 5 30		
Triangles, West Reef, Kay at S.W. end	20 58 0	92 19 30		
East Reef, beacon	20 54 54	92 13 21		
Obispo Shoals, spot of 16 ft.	20 26 30	92 14 30		
Arcas Kays, Western Kay	20 12 35	91 59 38		
Placer Nuevo or New Bank, centre........................	20 32 0	91 53 0		
Campeche, Fort San José	19 51 36	90 31 30	6 25	
Lerma, Church...............	19 48 24	90 36 45		
Carmen Island, West end	18 38 44	91 51 46		Lieut. Lawrance, 1850, and others.
Xicalango, Lighthouse ...	18 37 47	91 54 46		
River Tabasco, Lighthouse	18 39 30	92 42 0		
Coatzacoalcos Lighthouse	18 8 56	94 24 47		United States Officers, 1889.
Zapotitlan Point	18 35 0	94 48 0		
Alvarado, Bar	18 50 0	95 46 0		
VERA CRUZ, San Juan de Ulloa, Lighthouse.........	19 12 30	96 7 57	7 20	U.S. Officers, 1883-4.
Lobos Kay, centre	21 29 0	97 13 30		
Tampico, Light...............	22 16 0	97 49 0		United States Coast Survey.
Rio Grande, entrance	25 57 0	97 6 15	8 40	United States Coast Survey.
Brazos Santiago, Isabel Point, Lighthouse	26 4 36	97 12 23		(See also page 72).

NOTE.—In this concluding Section the following may be considered as well-ascertained positions, viz.:—Cayenne; Demerara; La Guayra; Aspinwall; Great Corn Island; Old Providence; Isabel, in the Gulf of Dulce; English Kay; Allen Point, Ascension Bay; Sisal Fort; Lerma Church; Coatzacoalcos; and Vera Cruz.

The VARIATION of the COMPASS is subject to very little annual change on the coasts of Central America, &c.

SECTION II.

GENERAL OBSERVATIONS ON THE WINDS, TIDES, AND CURRENTS; AND ON THE DIFFERENT PASSAGES OVER THE NORTH ATLANTIC OCEAN.

1.—GENERAL REMARKS ON THE WINDS.

(1.) This book is intended as an introduction to the series which describes the six great Oceans, and of which it forms the first volume; it therefore includes some topics which are common to them all, though only incidentally touched upon in the other volumes. In the preliminary chapters, some general remarks on Ocean Meteorology are given at greater length than some might consider necessary in a work like this; but as the greater number of sailors commence their labours in the North Atlantic Ocean, they are given here for the benefit of those who take more than a passing interest in subjects which so much affect the courses of their daily life.

This science of Ocean Meteorology, whether as regards the phenomena of the atmosphere or of the sea, has been greatly elevated in importance of recent years, especially since the time when the Conference at Brussels, in 1853, led to the establishment of the Meteorological Department, and to the co-operation of numerous allied institutions. But, once for all, it must be to Captain Maury that we should attribute the merit of initiating the topic in its modern phase.

Since the development of the telegraphic system, which has enabled observers to rapidly collect and co-ordinate the various meteorological data from distant but connected stations, some remarkable results have been arrived at, which will be more fully entered into in the next section.

(2.) As the sailor deals not with speculation, but applies the facts of Nature to his use, the mode in which the whole mass of the atmosphere is interchanged and mingled is important to him only as a field of observation which he enjoys with the rest of mankind. The present object being practical utility, the Theories of the Winds will be only briefly alluded to here, leaving the reader to those numerous and voluminous works now extant on these subjects for a more full elucidation of them.*

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* These and other subjects are more fully alluded to and described in a "Text-book of Ocean Meteorology," compiled from the Sailing Directories for the Oceans of the World, by A. G. Findlay, F.R.G.S., and edited by Staff-Commander W. R. Martin, R.N. Published by R. H. Laurie.

The scientific aspects of Ocean Meteorology are well treated of in Part II. of the Annual Report, 1885, of the Chief Signal Officer to the War Department of the United States, entitled "Recent Advances in Meteorology," by William Ferrel, M.A., Ph. D.; also in "A Popular Treatise on the Winds," by the same author, 1889.

As a broad and primary principle, it may be affirmed that the complete circulation of the atmosphere is demonstrated by the fact that the air is composed of precisely the same elementary constituents in every part of the world. This fact was practically demonstrated many years since by the French Academy of Sciences, who had bottles of air most carefully collected in all regions, and submitted to the most rigid analysis, which failed to discover any difference whatever. It is manifest in a natural sense, also, by its supporting animal and vegetable life universally in the same manner. If it were not so, the air over a special region would, in the course of ages, have become subject to the emanations and influences of the land it covered. The same remark holds good, also, with the water of the Ocean, equally universal in its definite characteristics, and from the same cause, as will be shown hereafter. The manner in which this is carried on is still involved in some mystery, although these difficulties are disappearing before the rigid investigations which are now pursued and applied to each new fact as it arises.

(3.) In the year 1686, Edmund Halley* proposed the theory of the Trade Winds and Monsoons, which is now generally received as an approximation to the true solution. He afterwards altered his views, which were revised and extended by George Hadley, in 1735.† The following is a brief summary of them:—

(4.) The sun is constantly vertical over some part of the earth between the Tropics, and this zone is consequently maintained at a much higher temperature than the regions nearer the Poles. This heat on the earth's surface is imparted to the air, which is therefore expanded, displaced, and buoyed up from the surface, and the colder, and therefore denser and heavier air from without glides in on both sides along the surface. The displaced air, thus raised above its due level, and unsustained by any lateral pressure, flows over, as it were, and forms an upper current in the contrary direction, or towards the Poles; which, being cooled in its course, and also sucked down to supply the deficiency in the extra-Tropical regions, keeps up thus a continual circulation.

At the Equator the velocity of the earth's rotation is 1,036 miles an hour, in lat. 30° it is 897 miles, and in lat. 60° only 518 miles. Since the Equator revolves so much more rapidly than the portions nearer the Poles, it follows, that a mass of air flowing towards the Equator must be deficient in rotary velocity, and, therefore, unable to keep up with the speed of the new surface over which it is brought. Hence these currents from the North and South must, as they glide along the surface, at the same time lag or hang back, and *drag upon* it in the direction *opposite* to the earth's rotation, *i.e.*, from East to West. Thus, from simple Northerly and Southerly winds, they become permanent *North-Easterly* and *South-Easterly winds*.

The lengths of the diurnal circles increase very slowly near to the Equator, and for several degrees on each side of it hardly change at all. It follows from this, then, that as these winds approach the Equator, their Easterly tendency must diminish, and at the Equator must be expected to lose their

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* Philosophical Transactions, xvi., page 153.

† Ibid., 1735, page 58.

Easterly character altogether. And not only this, but the Northern and Southern currents, here meeting and opposing, will mutually destroy each other, leaving only the actions of local causes, which may lie in one region in one way, and in another in a different one.

The result of this, then, is the production of two great Tropical belts of North-Easterly and South-Easterly winds, while the winds in the Equatorial belt which separates them should be free from any steady prevalence of an Easterly character, and should also be comparatively calm. All these consequences are agreeable to observed fact, and constitute the system of the regular *Trade Winds.*

(5.) The constant friction of the earth upon the air near the Equator, it may be objected, would, by degrees, destroy the rotation of the whole mass; but it is compensated in this manner: the heated Equatorial air, rising and flowing off toward the Poles, carries with it a rotatory velocity much greater than that of the surface over which it passes in its Northward and Southward progress. Hence it will gain more and more on the surface of the earth, and assume more and more a *Westerly* relative direction; and when, at length, it necessarily returns to the surface in its circulation, which it must do, more or less, in all its course, it will act on it by its friction as a powerful S.W. wind in the Northern Hemisphere, and a N.W. wind in the Southern, and thus restore the equilibrium. Some consider that this is the origin of the S.W. and Westerly gales so prevalent in our latitudes, and of the almost universal Westerly winds in the Northern part of the North Atlantic Ocean.*

(6.) Now it will be seen that by this theory the Trade Winds *meet* near the Equator, leaving a belt of Calms of varying breadth between them. According to Commander Maury, the winds here being neutralized rise up, and *cross each other;* the wind brought by the S.E. Trade passing over the N.E. Trade as a S.W. upper current; and, having passed the Calms or Variables of the Tropic of Cancer, it appears as the ordinary Anti-Trade or S.W. prevalent wind. The chief physical fact upon which this theory is based is the red dust, found frequently to fall on vessels near the Cape

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* Sir John Herschel gives the following note in his work upon the Origin of Storms, which, as it is most feasible, we give here; it must be observed that it was written before the views and observations of Reid, Redfield, and others, had been published. We shall advert to it hereafter.

"It seems worth enquiry, whether Hurricanes in tropical climates may not arise from portions of the upper currents prematurely diverted downwards before their relative velocity has been sufficiently reduced by friction on, and gradually mixing with, the lower strata; and so dashing upon the earth with that tremendous velocity, which gives them their destructive character, and of which hardly any rational account has yet been given. Their course, generally speaking, is in opposition to the regular Trade Wind, as it ought to be, in conformity with this idea.—(*Young's Lectures*, vol. i., page 704.) But it by no means follows that this must always be the case. In general, a rapid transfer, either way in latitude, of any mass of air which local or temporary causes might carry *above the immediate reach of the friction of the earth's surface*, would give a fearful exaggeration to its velocity. Wherever such a mass should strike the earth, a Hurricane might arise; and should two such masses encounter in mid-air, a Tornado of any degree of intensity on record might easily result from their combination."—*Astronomy*, page 132. The more recent views of Sir John Herschel and others will be found in their place hereafter.

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Verde Islands, and in the Mediterranean, where it is called sirocco dust (as coming from the South). This red dust was found by Ehrenberg to consist of microscopic infusoria and organizations, whose habitat, *as far as was known*, is in South America. But this argument may be demurred to from the limited extent this dust falls upon compared with the vast area from which it is said to be derived.

(7.) There is another great difficulty in the reception of this theory, in the great breadth, in some parts, of that intervening band of Calms where these supposed currents are to cross each other. In the Eastern part of the Atlantic it is from 300 to 600 miles in breadth. If this great interchange of directions were continually going on with such a vast amount of atmosphere, we may safely conclude that the lower strata would not be characterized as they are by the Calms or "Doldrums."

(8.) The more reasonable argument, in the present state of our knowledge, is, that the Trade Winds reaching this belt of Calm, by far the greater part of the indraught will rise on its own side, and revert towards the Pole of its own denomination in a precisely opposite direction to that by which it arrived. In the parts of the Equatorial regions where this intervening Calm belt is much narrower, as on the East coast of America, this crossing may take place, and the upper currents pass on towards the Poles of *contrary* names. At all events, this view of the circulation of the atmosphere will satisfy our present proposition—that every particle of air has been so commingled with the rest, that it produces the universality of character which is demonstrated to exist. As stated before, these theories are practically unimportant to the sailor in his profession, but are highly interesting to him as a subject for observation and reflection.*

(9.) It has been held by many that the solar heat, combined with the revolution of the earth, is sufficient to account for the general phenomena of the Winds; but there are still some difficulties in the way of accounting for some of the periodical winds which are found to recur with great regularity. Mr. Hopkins points out that the Trade Wind at times blows towards areas of great condensation, inferring that a great rain-fall occasions a corresponding indraught.† This view of Mr. Hopkins is modified by other observations, which lead to the inference that currents of air move *around* areas of high or low pressure, the latter condition being that which usually attends the greatest rain-fall. This is adverted to presently.

It is also contended by some that the lowest stratum of the air, having its velocity kept down by friction, generally moves from the Tropical belts of high barometer to the regions of low barometer at the Poles and Equator.‡ Thus, the N.W. and S.W. Anti-Trades constitute *under* currents toward the Poles, beneath an upper current, also toward the Pole, and a middle return or compensating current; and that the crossing of the winds at the Tropic is a physical impossibility.

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* See further on these subjects, Maury's "Physical Geography of the Sea."

† Mr. Hopkins: "The Atmospheric Changes that produce Rain and Wind;" also see Journal of the Royal Geographical Society, 1856, pp. 158, et seq. See, also, D. Vaughan, U.S., in British Association Report, 1860, page 41.

‡ See Professor J. T. Thomson, in Report of the British Association, 1857; and Professor J. D. Everett, in the same Journal, 1871, page 54. A vast mass of data is given in Professor James H. Coffin's "Winds of the Northern Hemisphere," hereafter quoted (page 107).

Another view of the cause of atmospheric circulation is that by Professor Laughton, of Portsmouth, who contends that it is due to aëro-tidal or mechanical causes. He supposes that the prevailing Westerly wind of high latitudes is caused by the influence of the moon, and that the modifications of this wind, caused by the coasts which bound the sea, are the sources of all other winds. For instance, he says when our Westerly wind strikes the coast of Portugal, it will branch to the N~~orth and~~ South as any fluid would do under similar circumstances, and that eventually it will recurve to the Westward to fill up the space from which the air forming the original Westerly wind had moved. Thus eddying, as it were, in two great circuits, and carrying the surface waters with it, causing the main Currents of the Ocean.*

There can be no doubt that land frequently offers an obstruction to a current of air, and diverts its course, but this theory does not take into account the changes which come with the seasons; they seem to be due to Temperature.

(10.) The Honourable R. Abercromby considers that the popular idea about the circulation of the atmosphere over the Equator is certainly erroneous. It is usually supposed that the N.E. and S.E. Trades meet over the Doldrums, and that the air then rises and pours back to the nearest Pole. He says:—"The result of my own observations in the Doldrums of both the Atlantic and Indian Oceans, points to the conclusion that at high levels the two Trades rather tend to coalesce into a single Easterly current, and that the poleward motion of air near the Equator is very small. The propagation of the dust ejected by the great eruption of Krakatoa, in 1883, confirmed this view. The dust went round the world in a belt near the Equator in about four days, and did not reach middle latitudes till two or three months later."† As this dust, however, is considered to have been projected far above the region influenced by the action of the Winds (12), this argument is not conclusive.

(11.) There is one feature of the atmosphere which has been involved in some obscurity, or, at least, has been the subject of controversy. It is the condition of *Aqueous Vapour*, at all times present in the air. It is a very important question, as upon this water-bearing property of the air, evaporation, condensation, and rain depend, and consequently climate and fertility to the earth. Air charged with vapour is specifically lighter than dry air, thus diminishing the atmospheric pressure where it exists, and this is well illustrated by the low pressure existing over the moist Equatorial Calm Belt.

The doubts may be briefly stated. The eminent chemist, Dalton, demonstrated that one gas (and aqueous vapour is such) could permeate or exist in connection with another gas without displacing its bulk, and that water was thus diffused through the atmosphere without increasing its volume.

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* "Physical Geography in its relation to prevailing Winds and Currents."

† "Seas and Skies in Many Latitudes," London, 1888, page 427; "Observations on Cloud Movements near the Equator," by the same author, in the Quarterly Journal of the Royal Meteorological Society, 1888, pp. 281—295.

Therefore, in estimating the height of the barometer, account must be taken of the amount (or weight) and elasticity (or tension) of the vapour, and *subtracted* from the height of the mercury, to give the true weight of the dry air. With a dew-point temperature of 87·35°, the pressure of moisture is equal to the weight of 1·26 inch of mercury, and must be *subtracted* from the height shown by the barometer, as before stated. This was the view held by Dalton, Ure, Regnault, Daniell, Sir Henry James, Alexander Buchan, &c.

In opposition to this, Professor Patton, of Bombay, maintained that moisture did *displace* an equal or equivalent volume of air, and that, therefore, it was only the difference of their amount which should be applied as a correction, and he estimated the amount of vapour above stated to be equal to a pressure of only 0·518 of an inch of mercury. But the first theory is thought to be the most feasible.*

(12.) Leaving the field of conjecture, we come to the actual condition of the atmosphere which covers the North Atlantic Ocean in particular, and the whole earth generally. Its elevation, or weight, is ascertained by the barometer, as is well known. According to the decrease in the height of the mercury on ascending to great elevations, it is calculated that at 15 miles the air is rarefied to about 25,000 times, and that at 80 or 90 miles a perfect vacuum exists. It presses with a mean force of 14·73 lbs. per square inch, and forms one 1,125,000th part of the mass of the whole earth.

The Trade Winds do not reach to more than 3 miles in height, and it is probable that all the phenomena of clouds and vapour occur beneath the height of 4 to 5 miles.

(13.) If the surface of the earth were evenly covered with land or water, or a combination of both, the phenomena of the Trade and Anti-Trade Winds would form symmetrical zones around the globe; but the relative proportions are very different in the two Hemispheres, being 100 land to 150 water in the Northern, and 100 land to 628 water in the Southern.† There is a still greater contrast, if we take the rational horizon of London as a great circle dividing the earth into two Hemispheres. It will be then seen that London is in the centre of that half which includes all the land, except Australia; and the other half includes nearly all the water of the globe. From this cause the line of meeting between the N.E. and S.E.

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* See "Abstracts of Meteorological Observations by the Royal Engineers, 1853-4," by Sir Henry James, R.E., F.R.S.; "The Handy Book of Meteorology," by Alexander Buchan, M.A., 1868, pp. 160—162; also, the later works of Professor Tyndall, &c.

† The dry land, as far as is known, is estimated to occupy 49,806,000 square statute miles. If this is increased to 51,000,000 for the unknown Polar regions, it will allow 146,000,000 of square miles to be covered by the Ocean.—*Sir J. Herschel.*

In a Paper on "The Height of the Land and the Depth of the Ocean," read by Dr. John Murray before the Royal Society of Edinburgh, and published in the Scottish Geographical Magazine, 1888, pp. 1—41, it is estimated that the area of the dry land is about 55,000,000 square miles, and of the Ocean 137,200,000 square miles. The mean Height of the land above sea-level is 2,250 ft., and the mean Depth of the Ocean is 2,080 fathoms, so that the Ocean could cover the whole surface of the globe to a depth of about 2 miles. It is also estimated that the rivers and floods annually carry 3·7 cubic miles of solid matter to the Ocean, and at this rate it would take 6,340,000 years to wash the whole of the dry land into the sea.

Trades is in all seasons *Northward* of the Equator in the Atlantic; and, from the land influences of Africa on the N.E. Trade Wind, there is a wide space of Calms, or doldrums, whose base lies against that continent, with its apex stretching toward the Coast of Brasil, as may be readily seen by referring to the Chart of the Winds, given in this work, which will explain this peculiarity far better than any verbal description.

(14.) The *Force* with which the Wind blows is one of the chief considerations of the sailor, in connection with his study of the subject. This force is readily measured in a fixed observatory, or on board a ship at anchor; but not so when she is under sail, as it is manifest that she is then apparently feeling less wind than is actually blowing, from being drifted before it. We have had some singular accounts of some of the fine clipper ships scudding at an immense rate before a gale, which has been marked as of no extraordinary violence; while other ships, dull sailers, have been dismasted or disabled by the fury of the same gale, from their not being able to bear away before its great velocity. Therefore, the *recorded* force of the winds met with at sea should be subject to this qualification—what are the sailing powers of the ship which has recorded them? It is manifest that a vessel, and especially a steam-vessel, will estimate the force of the wind acting on her in exact proportion to the direction from which she is meeting it or running before it. Thus, a vessel of good sailing power going before the wind, which, while stationary, she would estimate as having the force of 4, and running 5 or 6 knots before it, will appear only to have a force of a light breeze, or 3 knots; while, if a steamer went 10 knots against the same wind, it would appear to blow with a force of 7, or as a fresh treble-reefed topsail wind. We have no *standard* of sea-rates for the wind as yet. It would add to the value of such observations if the sailing powers of all ships engaged in adding to our knowledge could be tested both when close-hauled and running free upon a wind of known velocity.

In former times the vague terms of Breeze, Gale, Hurricane, &c., sufficed to describe the relative character of the wind. The late Sir Francis Beaufort devised a system of simple notation which more exactly defined these forces, and which is now in universal use at sea. The figures prefixed indicate the estimated character of the wind[*]:—

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[*] In addition to the *figures*, showing the Force of the Wind, the state of the Weather is to be understood by *letters*, as follows:—

Letters indicating the State of the Weather (Beaufort Notation).

b	Blue Sky.
c	Clouds (detached).
d	Drizzling Rain.
f	Foggy.
g	Gloom.
h	Hail.
l	Lightning.
m	Misty.
o	Overcast.
p	Passing Showers.
q	Squally.
r	Rain.
s	Snow.
t	Thunder.
u	Ugly (threatening) appearance of Weather.
v	Visibility. Objects at a distance unusually visible.
w	Wet (Dew).

NOTE.—A bar (—) under any letter indicates increased intensity:—thus $\underline{f}$ very foggy, $\underline{r}$ heavy rain, $\underline{\underline{r}}$ heavy and continuing rain, &c., &c.

Beaufort Notation.

	Velocity.*		
0. Calm	0 – 3 Miles per Hour.		
1. Light Air	8	Just sufficient to give steerage way.	
2. Light Breeze	13	With which a well-conditioned sailing Ship of War, with all sail set, would go in smooth water and "clean full," from	1 to 2 knots.
3. Gentle Breeze	18		3 to 4 knots.
4. Moderate Breeze	23		5 to 6 knots.
		To which she could just carry in chase, "full and by":—	FOR SHIPS RIGGED WITH DOUBLE TOPSAILS.
5. Fresh Breeze	28	Royals, &c.	
6. Strong Breeze	34	Single-reefed topsails & topgallant sails.	6. Topgallant sails.
7. Moderate Gale	40	Double-reefed topsails, jib, &c.	7. Topsails, jib, &c.
8. Fresh Gale	48	Treble-reefed topsails, &c.	8. Reefed upper topsails and courses.
9. Strong Gale	56	Close-reefed topsails and courses.	9. Lower topsails and courses.
10. Whole Gale	65	With which she could scarcely bear close-reefed maintopsail and reefed foresail.	10. Lower main topsail and reefed foresail.
11. Storm	75	Which would reduce her to storm stay-sails.	
12. Hurricane	90	Which no canvas could withstand.	

(15.) The wind over the land is found to be generally of much less force and velocity than at sea, so that the Beaufort Notation was found inconvenient for land purposes: Mr. Glaisher, therefore, proposed another Notation for this use, which was adopted at Greenwich, Liverpool, and indeed at most of the principal Observatories. It divides the Force into the numbers 1 to 6, which have been proportioned to the Beaufort Scale, as follows:—

Glaisher Notation.

1. Moderate	(Beaufort Scale 1—2)	4. Heavy	(Beaufort Scale 7—8)
2. Fresh	(„ 3—4)	5. Violent	(„ 9—10)
3. Strong	(„ 5—6)	6. Tremendous	(„ 11—12)

(16.) From numerous observations made during the voyage of H.M.S. *Challenger*, it was found that the *Mean Hourly Velocity* of the wind over the ocean was 17½ miles, and on land only 12½ miles.

(17.) The actual Force and Velocity of the Wind were calculated by Sir W. Snow Harris, with an improvement of Lind's Anemometer, by which he found air moving 20 feet in a second presses on 1 square foot with a force of about 13 oz. avoirdupois, or at 50 feet per second it would support a column of water 1 inch high, the pressure force increasing very nearly with the square of the velocity. With these data the Table on the following page has been calculated:—

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* The Velocity of the Wind, given in Miles per Hour, is taken from the work entitled "Aids to the Study and Forecasts of the Weather," by W. Clement Ley, M.A., published by the Meteorological Council.

TABLE,

Showing the Force and Velocity of the Wind from Light Airs to Heavy Gales and Tempests.

Pressure in lbs. on Square Foot.	Velocity.		Popular Descriptions.
	Feet per Second.	Miles per Hour.	
0·002	1	0·68	Gentle airs (unappreciable by guage). (*Beaufort Scale*, 1).
0·004	1·47	1	
0·019	3	2	Light airs (just appreciable by guage); would fill the lightest sail of a yacht. (*Beaufort Scale*, 2).
0·032	3·9	2·66	
0·043	4·5	3	
0·065	5·28	3·6	Light breezes, such as would fill the lightest sails of a large ship (3).
0·071	5·87	4	
0·090	6·6	4·5	
0·100	6·98	4·75	
0·112	7·34	5	
0·130	7·89	5·38	
0·162	8·8	6	
0·228	10·4	7	
0·260	11	7·6	
0·291	11·8	8	Moderate breezes, in which ships can carry all sail (4).
0·364	13·2	9	
0·390	13·6	9·27	
0·452	14·7	10	
0·521	15·8	10·77	
0·551	16·2	11	
0·650	17·66	12	
0·780	19·3	13	Fresh breezes; topgallant sails and royals (5).
0·830	20	13·6	
0·884	20·6	14	
0·910	20·9	14·25	
1·042	22	15	
1·170	23·6	16	
1·250	24·2	16·5	
1·302	25	17	Fresh winds; reefs (6).
1·470	26·5	18	
1·563	27·39	18·67	Strong winds; treble-reefed topsails (7).
1·630	28	19	
1·790	29·35	20	
2·084	31·15	21·47	Gales; close-reefed topsails and reefed courses (8).
2·600	35·32	24	
3·126	38·73	26·40	Strong gales; close-reefed topsails and stay-sails (9).
3·647	41·83	28·52	
4·168	44·83	30·56	
4·689	47·44	32·34	
5·200	50	34	
7·800	61·18	41	Heavy gales and storms (10).
10·400	70·72	48·2	
13·000	79·07	53·91	
20·800	100	68·18	Very heavy gales; great storms; tempests (11).
26·000	111·74	76·18	
31·200	122·62	83·6	
41·600	141·30	90·84	Tornados; cyclones; hurricanes (12).
52·000	157·98	107·7	
62·400	173·06	120	

There is no question that the figures in this Table may be open to some doubt, as the subject is a difficult one, and they are given independently of the different forces exerted by aqueous vapour and by air. Sir Henry James also drew up a more complicated Table, and foreign and other observers have also prepared various other Tables, differing more or less from that just given, which will suffice for the sailor's use.

The results vary much, according to the form of Anemometer used. From exhaustive experiments recently made by Mr. W. H. Dines, it was found that the pressure upon a plane area of fairly compact form is about 1½ lb. per square foot at a velocity of 21 miles per hour, or in other words, a pressure of 1 lb. per square foot is caused by a wind of a little more than 17 miles per hour.*

After the disastrous failure of the Tay Railway Bridge and other structures, owing to heavy gales, an inquiry into the subject led Mr. Thomas Hawksley to draw up the following Table.†

Pressure in lbs. per Square Foot.	Velocity.		Pressure in lbs. per Square Foot.	Velocity.	
	Feet per Second.	Miles per Hour.		Feet per Second.	Miles per Hour.
0·25	10	6·8	20·25	90	61·2
1·0	20	13·6	25·0	100	68·0
2·25	30	20·4	30·25	110	74·8
4·0	40	27·2	36·0	120	81·6
6·25	50	34·0	42·25	130	88·4
9·0	60	40·8	49·0	140	95·2
12·25	70	47·6	56·25	150	102·0
16·0	80	54·4			

(18.) *The Alternation of the Sea and Land Breezes* in warm latitudes is an important feature in coast navigation. Its cause is generally well understood, being owing to the different powers of radiation and absorption of heat possessed by land and water. So that, generally, when the day temperature is highest on the land, the strongest will be the alternating breezes. During the day the radiation of the sun's heat on the land causes the air to expand and rise from the surface, and then the sea air rushes in to fill the void. It frequently occurs that the surface of the soil will show a temperature of 120° under the meridian sun, and sink to 50° or 60° during the night; while the sea, rarely having a higher temperature than 80°, and from being a bad radiator fluctuates but very little, it follows that it is alternately warmer and colder than the land, and hence the phenomena in question. The minimum temperature of the twenty-four hours occurring a little before sunrise, and the maximum about 2 p.m., the change of these breezes occurs generally at some little time after those hours.

The above theory of Land and Sea Breezes does not satisfactorily account for the known fact that the Sea Breeze always sets in first in the offing, and not on the coast. Professor Laughton accounts for the Sea Breeze by the excess of barometric pressure seaward owing to evaporation, and for the Land Breeze by the descent of the column of air forced up by the Sea Breeze. It is to be remarked that *both* Land and Sea Breezes are only well developed on coasts backed by hills.

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* An account of these experiments is given in the Report of the Meteorological Council to the Royal Society, for the year ending March 31st, 1890, pp. 36—45.

† "On the Pressure of the Wind upon a Fixed Plane Surface," by Thos. Hawksley, C.E., F.R.S., in the Report of the British Association, 1881, pp. 480—482.

(19.) The wind decidedly *veers* round the compass according to the sun's motion, *i.e.*, in the Northern Hemisphere from North through N.E., East, S.E., to South, and so on, often making a complete circuit in that direction, or more than one in succession (perhaps occupying many days in so doing), but it rarely *backs*, and very rarely, or never, makes a complete circuit in the contrary direction, except in very high latitudes. Professor Dové argued this to be the direct consequence of the rotation of the earth; and, although the observation was recorded by Lord Bacon, in 1600, it is now known as *Dové's Law of Gyration.**

(20.) Professor Coffin, from his elaborate discussions, considered the following to be a general description of the Wind system of the Northern Hemisphere:—

1st. That from high Northern latitudes the winds proceed in a Southerly direction, but veer towards the West as they approach a limit ranging from about lat. 56° on the Western continent, to about lat. 68° on the Eastern, where they become irregular and disappear. The area of this zone is about 11,800,000 square miles.

2nd. That farther South there is a belt of Westerly winds, less than 2,000 miles in breadth, entirely encircling the earth; the Westerly direction being clearly defined in the middle of the belt, but gradually disappearing as the limits are approached on either side. The area of this zone is estimated to be about 25,870,000 square miles.

3rd. That South of the zone last named the mean direction of the wind is Easterly. This area is estimated to contain 60,760,000 square miles.†

Professor Dové contended that there are but two systems, the 1st and 3rd of the foregoing.‡

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* When speaking of the wind veering with the sun, of course the shifting of the cyclonic winds in the Northern Hemisphere is not included.

† "Winds of the Northern Hemisphere," by Professor Coffin, A.M., Pennsylvania, U.S., in "Smithsonian Contributions to Knowledge," vol. vi.

‡ See Report of the British Association, 1845. See, also, Professor Mitchell, in the American Journal of Science and Arts, vol. xix., page 254. A great amount of information will be found on the general subject in the works of Kämtz and Romme, who have also laboriously studied and generalized the phenomena of the Winds, and to whose labours much that is here said is owing.

2.—THE MOTIONS AND PRESSURE OF THE ATMOSPHERE, with Introductory Remarks on the Use of the Barometer.

(21.) As so many references will be made in the succeeding pages to the indications afforded by that invaluable instrument, the Barometer, we here give a few remarks upon its use. So much depending upon the readings being correct, masters of vessels are advised to compare their Barometers as often as possible with Standard instruments on shore, so as to ascertain the exact error if any. This can easily be done, without removing the ship's Barometer (in ports where reliable Barometer observations are daily taken, at a stated time, with a Standard instrument), by taking an observation on board at the same time, correcting it for previous error (if any) and temperature, and then comparing the result with that of the Standard. An Aneroid should always be gently tapped before it is read off, to make sure that the pointer marks correctly.

The Barometer should be set and read at regular hours, every four hours if possible in a general way, or more frequently when a change in the weather is imminent, and the readings entered at once in the log.

(22.) Corrections are necessary in the reading of the Mercurial Barometer to reduce its indications to the standard temperature of 32° F. at sea-level. As the column of mercury shortens when cooled and lengthens when heated, allowance must be made according to the temperature recorded by the attached Thermometer, and deduction made as follows:—At 40° F., ·03: 50°, ·06: 60°, 0·8: 70°, ·11: 80°, ·14. An addition of about ·001 must also be made for each foot that the instrument is placed above sea-level. A slight correction for temperature must also be made for observations with Barometers having a brass scale extending upwards from the cistern, for which a Table is given at the end of this work. Thus, at 40° F., bar. 30·0, ·031 must be deducted: at 50° F., ·058; at 60°, ·085; at 70°, ·111; at 80°, ·138; the difference for ·5 above or below 30·0 being only ·001 to ·002.

In making entries in the ship's log only the actual reading of the Barometer should be recorded, with the temperature of attached Thermometer.*

(23.) **Barometer Normals.**—Owing to the regular observations made and recorded in sea-ports and ships' logs for long series of years, it has been rendered possible to draw up Charts and Tables showing that the barometric pressure lies in regular zones over the Ocean, and by comparing his observations with these records the seaman may readily ascertain whether there is any serious departure in these readings from the mean pressure, either in the way of excess or deficiency, and this knowledge, combined with observations of the actual direction and force of the wind, and of the changes that take place in these, will furnish him with the means of guiding his action with confidence, as will be further explained hereafter.

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* The French, and other nations using the decimal system, apply it also to the Barometer scale, the latter being marked in *millimètres*, 1 of which = nearly ·04 inch (·03937). The following amounts are equivalents:—27 inches, 685·8 millimètres; 27·5 in., 698·5 mm.; 28·0 in., 711·2 mm.; 28·5 in., 723·9 mm.; 29·0 in., 736·6 mm.; 29·5 in., 749·3 mm.; 30·0 in., 762·0 mm.; 30·5 in., 774·7 mm.

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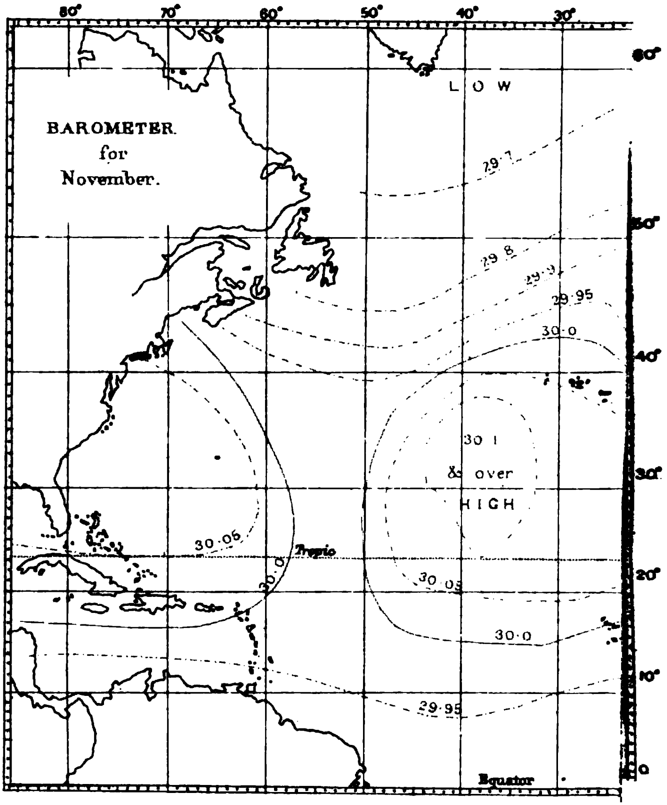

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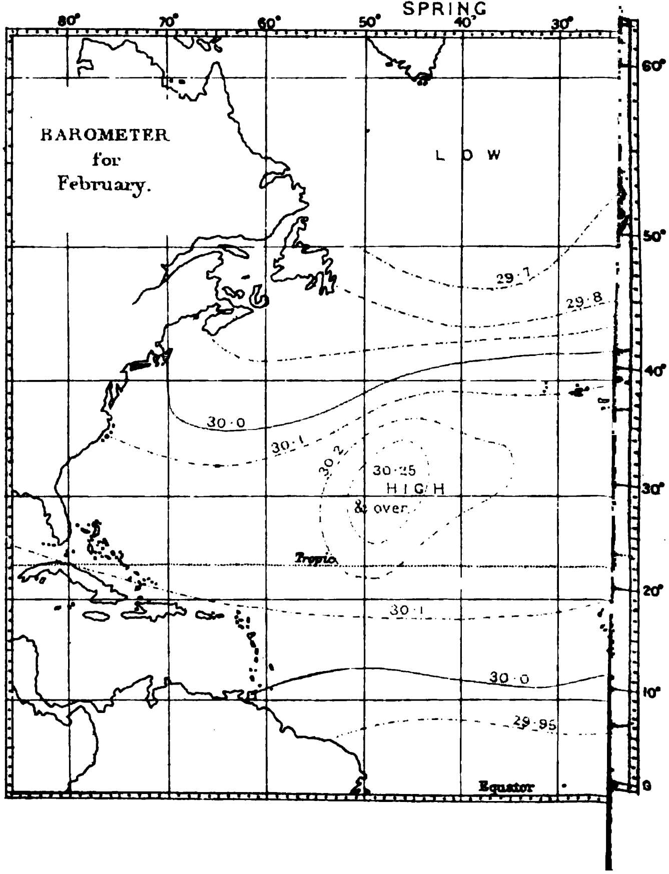

The accompanying diagrams are taken from the "Charts showing the Mean Barometric Pressure over the Atlantic, Indian, and Pacific Oceans," published by the Meteorological Council, in 1887. On these charts the observations are considered as taken with the cistern at 11 feet above sea-level, reduced to 32° F. The months selected are February, May, August, and November, as representing the Winter, Spring, Summer, and Autumn seasons of the Northern Hemisphere. The probable pressure for the intervening months can be easily deduced with fair accuracy.

We may also refer here to the useful Table of Barometer Normals appearing on the United States monthly "Pilot Chart of the North Atlantic Ocean," published at the Hydrographic Office, Washington. These differ slightly from the figures shown on the above charts.

As stated in (21), unless the exact error (if any) of the ship's Barometer is known, no practical use can be made of these Charts or Tables.

(24.) The lines drawn on the diagrams show where certain barometric pressures, indicated by the figures upon them, are observed. These lines are termed *isobaric lines*, or *Isobars*, because they pass over places having equal barometrical pressure. It will be seen that, speaking generally, in winter the barometer is highest over the land, which is then colder than the sea; and lowest over the sea, which is then warmer than the land. In summer the barometer is lowest over the great continents, which are then relatively hot, and highest over the sea, which is then relatively cool.

Over the Equator, and between the Tropics, where the temperature is always comparatively high, the barometer is low relatively to the neighbouring zones just beyond the Tropics, where the temperature is relatively low, and the barometer is high.*

(25.) The main features brought out by these Charts are that over the sea the pressure is more uniform throughout the year than over the continents, and that, roughly speaking, the Ocean, that part of the earth's surface which more immediately concerns the seaman, may be divided in respect of barometric pressure into *five* great areas.

First, a belt of moderately *low* pressure, over the Calm belt of the Equatorial region. Then, North and South of the Equatorial region, are two belts of *high* pressure, over the Trade Wind regions. Proceeding to the higher latitudes, and towards the Poles, we again find, in each Hemisphere, an area of *low* and diminishing pressure.

In the Equatorial region the barometer stands at, or close to, 30·0. From the Tropic to about lat. 40° N. and S., the readings are above 30·0, and in the central parts of the oceans readings as high as 30·2 are found over large areas. North and South of the parallels of 40°, the pressure diminishes, and in mid-winter, South of Greenland and Iceland, an area of low pressure, 29·4, exists, which disappears in mid-summer, the barometer then standing half an inch higher.*

Captain Toynbee also remarked in a lecture at the United Service Institution, May 19th, 1871:—"Having treated of the more permanent areas of high and low pressure in the North Atlantic, here let me add, that similar areas of high and low pressure are found to exist in the other great oceans. If these areas were quite fixed, and the only disturbances to which the air of the North Atlantic was subjected, the direction and force of the wind might be expected to be equally fixed. But, besides the above, local and temporary disturbances are very common."

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* "A Barometer Manual for the Use of Seamen," published by the Meteorological Council.

(26.) The diagrams show the *mean* barometrical pressure, but this is liable to variation from several causes, periodical and non-periodical.

The *Diurnal Variation* (mainly due to temperature) is one of the most regular of recurring phenomena in the Tropical and adjacent seas, gradually diminishing in higher latitudes, and is hardly perceptible within the Arctic and Antarctic Circles. This diurnal variation of pressure consists of a double oscillation, there being two periods of increase and two of decrease; the barometer rising from about 4 a.m. to about 10 a.m., then falling to about 4 p.m., and again rising till about 10 p.m., when it once more falls to 4 a.m. In Tropical seas the daily range between the highest and lowest may be taken at about ·07 or ·08. In the British Isles the changes of pressure due to this cause are hardly more than one-fourth of those observed in the Tropics, amounting on the average to about ·02.

The *Annual Variation* of pressure is also a well-marked phenomenon within the Tropics, and in these seas it amounts to about ·10; on approaching the land it becomes much greater. As, however, the annual variation takes place very gradually, it calls for no further comment here.

The *non-periodical* changes of pressure are those immediately associated with changes of weather. The extent of these changes, under ordinary conditions, and taking the average of the various seasons of the year, varies with the latitude, being smallest near the Equator and increasing as we recede from it. Within the Tropics, the ordinary fluctuations of the barometer, including the diurnal variation, seldom exceed ·3 or ·4, except in the event of one of those furious and dreaded revolving storms commonly known as Hurricanes, Cyclones, or Typhoons (according to the part of the globe in which they occur), when the barometer may fall much more, and in the dangerous part of the storm-field may fall to the extent of 2 inches or more. The magnitude of the range in the higher latitudes, as compared to the Tropics, is exemplified in the British Islands, where the average range in the course of a month is about 1·7 for January, and 0·9 for July.

(27.) **Range.**—The following Table is given in the "Barometer Manual"

	January.	July.
	Inch.	Inch.
Between Lat. 65° and 60° N.	1·70 to 1·80	1·0
60° — 50°	1·80 — 1·50	1·00 to 0·80
50° — 40°	1·50 — 1·25	0·80 — 0·60
40° — 30°	1·25 — 0·65	0·60 — 0·40
30° — N. Tropic	0·65 — 0·40	0·40 — 0·30
N. Tropic — Equator	0·40 — 0·20	0·30 — 0·20
Equator — S. Tropic	0·20 — 0·35	0·20 — 0·35

as the approximate range of the Barometer, under ordinary conditions of weather. In severe storms the range is naturally much greater; as an example it may be stated that during the great storm of January 26th, 1884, the barometer in Leith fell to 27·60 inches, and at Kilcreggan, near Greenock, to 27·32 inches.

At the latter end of this work we give some further remarks on the Barometer, including those by the late Admiral FitzRoy, which may be referred to in connection with what has been stated in the foregoing pages on this subject.

Having thus briefly recorded the chief points to be observed in making use of the indications afforded by the Barometer, we now proceed to deal with the second part of this Section, referring to the Motions and Pressure of the Atmosphere.

(28.) Mr. W. Clement Ley, in the pamphlet previously quoted on p. 104, says:—Changes of Weather are closely related to changes of Wind, and changes of Wind to changes in the distribution of Atmospheric Pressure. It would not indeed be safe to assert that the weather conditions are, in all cases and absolutely, the effects of atmospheric currents, or that the atmospheric currents are absolutely the effects of the distribution of pressure; for the inter-action between these several elements is not quite so simple as would be conveyed by such an assertion. When the atmosphere is in a state of equilibrium no movement of air can of course occur, but as soon as the equilibrium is disturbed a current of wind is generated, the air tending to move from the district of greater to the district of less pressure; in other words, the heavier air tends to drive out the lighter. Absolute equilibrium is in nature hardly ever attained, the air being kept in almost perpetual agitation by changes of pressure. The prime cause of atmospheric disturbance is found in the unequal distribution of solar heat over the earth's surface.

As soon as a current of wind is established, the effect of the earth's rotation on its axis is to cause this current to deviate to the *right* of what would otherwise be its course in the Northern Hemisphere, and to the *left* in the Southern. The winds thus blow to a certain extent *round* instead of *directly into* any area in which the pressure of the atmosphere is relatively low, and the centrifugal force of the currents themselves helps in this case to maintain the inequality of pressure.

This effect of the force of the earth's rotation varies with the latitude. In the high latitudes we find that if we describe lines along which at any given time the pressure of the atmosphere at the level of the sea is equal, while it is higher on the one side and lower on the other, the wind blows in a direction which, for practical purposes, may be regarded as parallel to those lines. In low latitudes, on the other hand, the winds move more nearly at right angles to such lines, and at the Equator the deflecting effect of the earth's rotation is zero, and the air must consequently there travel in direct lines from the points at which the pressure is greatest to those at which it is least.

(29.) The intimate connexion between the fluctuations of the Barometer and changes in wind and weather is familiar to all. As Mr. Piddington says: "The commander who is watching his Barometer is watching his ship, and that in the most efficient manner." This remark has a greater force now than when it was first made; because, since that period, the sailor has greatly extended the use of the Aneroid Barometer, which, by its immediately showing any atmospheric change, gives a longer and more assured warning. The Mercurial Barometer used at sea, from having its column much contracted in one part to overcome the "pumping" action which the vessel's motion would cause, is much more sluggish in its action, and hence it may not indicate a change till a part of its predictions has passed over.

(30.) But the isolated observation of the Barometer, and other indications of the condition of the atmosphere, made at sea, must necessarily be of infinitely less value in guiding the sailor than are those made within the range of the stations from which telegraphic Weather Reports are sent to each other, and by a comparison of which many very important conclusions can be quickly arrived at. It is this minute examination and comparison of the varied state of the meteorological conditions existing at one and the same moment at stations widely separated and extending over the West and N.W. of Europe, that some remarkable laws have been arrived at, and great advances made in the general subject of atmospheric meteorology.

(31.) But, although this method of comparison is not possible to the ship at sea, yet it is thought that the method by which "weather predictions" are made; the reasons why barometric pressures indicate certain general facts; why land disturbances from heat and cold, and differing temperatures in sea water, bring about, or point to, great and broadly-marked differences in wind and weather; are proper subjects for the sailor's study, and, as such, are not out of place here.

In laying as briefly as we can the results arrived at by the various observers, or by a combination of their deductions, we shall mostly give the words of the authors themselves, referring to the works quoted for more extended information.

(32.) When the Cyclone theory was propounded, which was in the first place done by Mr. Redfield, then by Sir W. Reid, Mr. Piddington, Dr. Thom, and other pioneers in this all-important subject, the "Law" was established that these Hurricanes in the Northern Hemisphere, having a low barometer in the centre of their vortex, will have this centre or vortex on the *left hand* of any one standing on its circumference with his *back* to the wind; the case being reversed in the Southern Hemisphere.

In the further investigation of the laws which govern the movements of the air, consequent on the recommendations of the Brussels Congress, the Dutch nation, well known to be foremost in the rank of enquirers, in 1857 established an Observatory at Utrecht, known as the Royal Meteorological Institute of Holland; and here the late Dr. Christopher H. D. Buys-Ballot pursued for several years an enquiry into the data afforded by the daily weather telegrams which were sent to this Observatory from several parts of the kingdom, and he arrived at the very important conclusion that the same Law which had been established by Redfield and Reid in regard to the local meteors, known as Cyclones, is applicable, on the very much broader scale, to the whole system of winds over the whole of the globe. But confining the remarks to the Northern Hemisphere, and more particularly to Holland, Professor Buys-Ballot determined the Law which is known by his name, and is briefly stated in these words:—

Buys-Ballot's Law.

If, on any morning, there be a difference between the barometrical readings at any two stations, in Holland, a wind will blow on that day, in the neighbourhood of places on the line joining those stations, which will be inclined to that line at an angle of 90°, or thereabouts, and will have the station where the reading is lowest on its left-hand side.

(33.) Dr. Buys-Ballot explained this Law, and the reasons for propounding it, and its application to an apparatus, termed an Aëroclinoscope, for indicating, each morning, at each port in Holland, the wind which may be expected to blow there during that day, in a pamphlet, dated 1860.*

This Law is the same as that known to hold good in the case of Tropical Cyclones, and also proved to be true in the case of winds in these latitudes, by Dr. Lloyd, in his "Notes on the Meteorology of Ireland," 1854. However, Professor Buys-Ballot was the first to insist on its importance as a means of foretelling wind, both as to direction and force.

(34.) The further investigation of this Law, and its application to weather predictions, were vigorously carried on by Capt. Henry Toynbee, F.R.A.S.,—a name well known to seamen—in connexion with the Meteorological Office; and in his Report on Isobaric Curves, 1869, he makes the following remarks on the general subject.

"Whilst considering Buys-Ballot's Law, I have been struck by a few facts which seem to indicate its relation to the general circulation of the air in moderately high latitudes. Here it may be well to repeat that Law, viz., 'If you turn your back to the wind (however light) in the higher Northern latitudes, there will be a lower pressure to your left than to your right hand.' This order is reversed in the Southern Hemisphere; hence it is probable that as the Equator is approached the wind will blow directly from a high towards a low pressure.

"With regard to the winds of the Northern part of the North Atlantic, during our winter a high barometer exists over the cold land in Europe and America, whilst it is relatively low over the sea, hence the prevalence of strong South-Westerly winds on our side of the Atlantic, and of North-Westerly winds in Newfoundland, as given in Mr. Buchan's work.† These winds work round an area of low pressure over the water, which seems to account for the prevalence of North-Easterly winds in Greenland.

"Then, as spring advances, the air over the land becomes heated, causing the barometer to fall, whilst water, changing its temperature much more slowly, does not act so quickly on the air above it, and the result is continents and islands. Over Siberia, in January, the mean height of the barometer is nearly thirty-one inches, whilst South of Iceland and Greenland it is about twenty-nine and a half inches, which fact well accounts for our prevailing S.W. winds in winter.

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* Eenige Regelen voor aanstaande Weersveranderingen in Nederland voornamelijk in verband met de dagelijksche Telegraphische seinen. Utrecht, 1860. An English version of this is "The Foretelling of the Weather in connexion with Meteorological Observations," by Captain F. H. Klein. Translated by A. Adriani, M.D., 1863.

† "A Handy Book for Meteorology," by Alexander Buchan, Second Edition, 1868.

"Knowing these facts, it is easy to realise that the storm-centres which come from the Atlantic towards our West coasts pass along the Northern side of the large area of high barometer which prevails in the neighbourhood of the Azores, and have the area of low barometer which prevails to the Southward of Iceland to the Northward of them. They are therefore, as it were, subsidiary to the larger system which is situated in the Atlantic, more especially in winter, and their Westerly winds are generally stronger than their Easterly winds, owing to the fact that the greater barometer difference or gradient is on their Southern sides."

(36.) BAROMETRIC WAVES.—In 1843, the late Sir John Herschel presented a report to the British Association on the result of some investigations he had made into the barometric changes registered at the term-days of the Equinoxes and Solstices, and arrived at the following conclusions:—

"1. We have succeeded in tracing distinct barometric waves of many hundreds of miles in breadth over the whole extent of Europe. Not only the breadth, but the direction of the front and the velocity of the progress of such waves have been clearly made out.

"2. Besides these distinctly terminated waves, we have been able, if not to trace the rate and law of progress, at least to render very evident the existence of undulating movements of much greater amplitude, so great indeed as far to exceed in dimension the area in question, and to require much more time than the duration of a term-series (36 hours) for their passage over a given locality. At the same time it must be recollected that the records of every meteorologist bear ample testimony to this conclusion in the fact of long-continued rises, falls, and stations (both high and low) of the barometer continuing for many days or even weeks.

"3. In Europe, Brussels is clearly entitled to be regarded as a point of comparatively gentle barometrical disturbance. Very *deep* waves it is true, and very extensive ones ride over it; but with regard to smaller ones it may be regarded as in a certain sense a nodal point where irregularities are smoothed down, and oscillatory movement in general is more or less checked; and such movements increase in amount as we recede from Brussels as a centre, especially towards the N.W. as far as Markree."

(37.) Mr. W. R. Birt, in the further enquiry into the subject of barometric waves, as reported to the British Association, between 1843 and 1848, established in the year 1846 the fact that each wave is accompanied by two streams of air, constituting two oppositely directed *winds;* and it is not a little interesting to remark, in passing, that this discussion, although unaccompanied by the actual projection either of barometric gradients or isobars, anticipated them both, inasmuch as the heights of the barometer are so arranged as to serve all the purposes of projected isobars and the determination of gradients, and this was effected as early as 1844, by barometric heights being treated *geographically*—an essential element of the isobar.

It will be needless to follow the progress of this subject through all its stages, but this will suffice to show that this important topic was investigated when the means of doing so were much more difficult to obtain, and that some of the decisions now accepted were clearly pointed out in former times.

In the course of Mr. Birt's researches on atmospheric waves, he had an opportunity of testing the correctness of Professor Dové's suggestion, which he found to be in close accordance with the truth, for he not only ascertained the existence of the S.W. and N.E. compensating currents, but also that of another set of oppositely directed and compensating winds at right angles to them. These were N.W. and S.E., with a lateral motion towards the N.E. He also carefully discussed the barometric phenomena with relation to both these sets of currents, and arrived at conclusions which the reader will find in detail in Mr. Birt's third report, presented to the British Association for the Advancement of Science (Report, 1846, pp. 132 to 162), but which may be briefly enunciated as follows:—During the period which passed under the examination of the writer, he found the barometer generally rising with N.E. and N.W. winds, and that as a maximum or *highest* reading of the mercury approached, the wind died away mostly to a calm. On the other hand, with S.W. and S.E. winds, the barometer generally fell, the force of the wind proportionally increasing until the mercury passed its minimum or *lowest* reading.

There is one important feature which the study of the Barometer has brought to light, and which is by no means devoid of significance, viz., that its oscillations are much greater in the neighbourhood of water. Thus it appears that the junction lines of land and water form by far the most important portions of the globe in which to study atmospheric waves; for, in the great systems of European undulations, it is well known that these oscillations increase, especially towards the N.W., and the late Professor Daniell shewed from the Mannheim observations that small undulations, having their origin on the Northern borders of the Mediterranean, have propagated themselves Northward; and thus, but in a smaller degree, the waters of the Mediterranean have contributed to increase the oscillations of the barometer, like the larger surface of the Northern Atlantic.

From such considerations as these, it becomes very desirable that our knowledge of the rise and fall of the Barometer, in immediate connexion with the direction and force of the wind on the surfaces not only of our large oceans, but also of those of our inland seas, and especially in the neighbourhood of extensive archipelagoes, should be increased.

(38.) In a future page, in the Section devoted to a description of the Winds encountered in the Northern part of the Atlantic, this subject of Atmospheric Waves will be again adverted to; and then it will be more plainly seen how it is applicable to the daily experience of the navigator.

(39.) Barometric Gradients.—The primary principle, that the atmosphere moves in a series of waves, indicated by the high or low pressure of the barometer, having been established, the next step was to estimate the dimensions of these waves, and the relation of this element to the changes in the wind's direction and force. In this enquiry several observers recorded the results of their work, including Mr. W. R. Birt, before mentioned, Dr. Lloyd, in his "Notes on the Meteorology of Ireland, 1854," and several other gentlemen; but Mr. Thomas Stevenson, C.E., in 1867,* was the first who proposed to define the dimension or magnitude of these atmospheric waves as "*Barometric Gradients,*" a term since adopted by the Meteorological Office. Its further development, and the application to weather predictions, have been carried out by the superintendents of that office, R. H. Scott, M.A., the Director, and Captain H. Toynbee.

Mr. Robert H. Scott, M.A., in his work entitled "Weather Forecasts and Storm Warnings," page 48, says:—"No very precise relation has yet been established between the amount of the gradient and the force of the wind, but a gradient of 0·02 inch per 15 miles indicates the probability of as much wind as an ordinary yachtsman likes to meet with." The Standard Gradients adopted by the Meteorological Office are expressed in hundredths of an inch of the mercury for a distance of 15 nautic miles, a measurement almost identical with that adopted on the Continent, of 1 millimètre for 60 miles.

The system of announcing the probability of a coming storm, inaugurated by the late Admiral FitzRoy, having been abandoned, it may be well to briefly allude to the system now in use, and this will be best done by quoting the words of the Report by Robert H. Scott, Esq.†

"In order to test the truth of this Law (Buys-Ballot's) as applied to our own daily Weather Reports, and its value as indicating the approach and progress of storms, I have investigated these Reports for a period of nine months, viz., from October to December, 1864, and from October, 1867, to March, 1868, inclusive. Captain Toynbee, the Marine Superintendent of the Office, has also been engaged in the study of these Reports.

"The observations discussed are all those taken at our own stations within the limits of the British Islands, and, in addition, those from Brest, L'Orient, Rochefort, and the Helder. In 1864, the Helder was not a reporting station, and accordingly Heligoland was taken instead. All these stations, except the last named, are situated within the area of a circle, 700 miles in diameter, whose centre is at Birmingham.

"The mode of investigation was threefold:—

"I. To ascertain the greatest difference of pressure existing between any two stations within the area, at 8 a.m. on each day, with the resulting direction for the wind according to the Law, and compare therewith the strong winds reported as having occurred during the twenty-four hours which succeeded the time of the observed barometrical difference.

"II. To extract the daily barometrical differences, and the resulting directions for the wind, along certain lines within the area, and compare therewith the winds recorded in the vicinity of those stations during the succeeding twenty-four hours.

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* In the Report mentioned in the note below,† Mr. Scott says:—"Mr. Stevenson measures his Gradients as an inch of mercury in a variable number of miles. I measure mine as a variable number of hundredths of an inch of mercury per 100 miles. Mr. Stevenson's Paper contains, as far as I am aware, the first proposal to estimate the intensity of storms *numerically*. It was printed in the 'Journal of the Scottish Meteorological Society' for January, 1868."

† "Report of an Enquiry into the Connexion between Strong Winds and Barometrical Differences," by Robert H. Scott, M.A., F.R.S.

"III. To extract each strong wind which was recorded at any station, and compare therewith the barometrical differences recorded along the lines in the vicinity of that station.

"By these three enquiries it was sought to ascertain :—

"1. What is the connexion between general barometrical disturbances and weather succeeding it.

"2. What accordance do the strong winds actually observed show with the directions over each district of the area as given by the Law.

"3. What amount of indication was given of each strong wind by barometrical differences in its vicinity."

(40.) We cannot here follow out the discussion into the details, but Mr. Scott drew this conclusion from them :—

"It appears, then, as a final result, that if we notice on any morning a difference of 0·60 inch between any two stations, the chance is 7 to 3 that there will be a storm within the succeeding twenty-four hours. On the other hand, the chance is 9 to 1 that any storm which sets in will be preceded by unmistakeable signs of its approach, although the barometrical difference of readings may not amount to 0·60 inch at 8 a.m.

"Before leaving this branch of the enquiry, there is one result which seems of sufficient importance to deserve a special notice.

"I find that although there is a preponderance of instances in which the difference of six-tenths is followed by a gale, yet on several occasions the barometrical inequality exists after the violent motion of the air has come to an end. In ten instances during the whole nine months, I find that at 8 a.m. on the day after a serious gale there was a difference of, or exceeding, 0·6 inch, while there was not a gale during the remainder of the day. This seems to me to be a very remarkable result, and one well deserving of future investigation.

"It appears, also, that as regards direction the Law receives strong confirmation :—

"Southerly gales are preceded by a relatively low pressure in the West.

"Westerly gales are preceded by a relatively low pressure in the North.

"Northerly gales are preceded by a relatively low pressure in the East.

"Easterly gales are preceded by a relatively low pressure in the South.

"In devising a system for testing the Law as applied to the different districts of the British Islands, and the North and West Coasts of France, we are met by various difficulties. The simplest statement of the Law is that according to it the wind at any point will blow in the direction of a tangent, at that point, to the isobaric curve which represents the atmospherical conditions existing a short time previously.

"Firstly, the whole system of isobaric curves, or the whole distribution of atmospherical pressure, is known to be subject to a motion of translation over the earth's surface; but of this motion the direction and the rate vary, from day to day, to a considerable extent, and in a manner independent of each other. Neither of these points have been as yet satisfactorily investigated. Secondly, the wind, especially in storms, seldom blows for many hours consecutively from the same point, but either *veers* or *backs*, the former motion being much more usual than the latter.

"These considerations show us that we must not interpret the Law too strictly, but must make some allowance for translation and for change of direction.

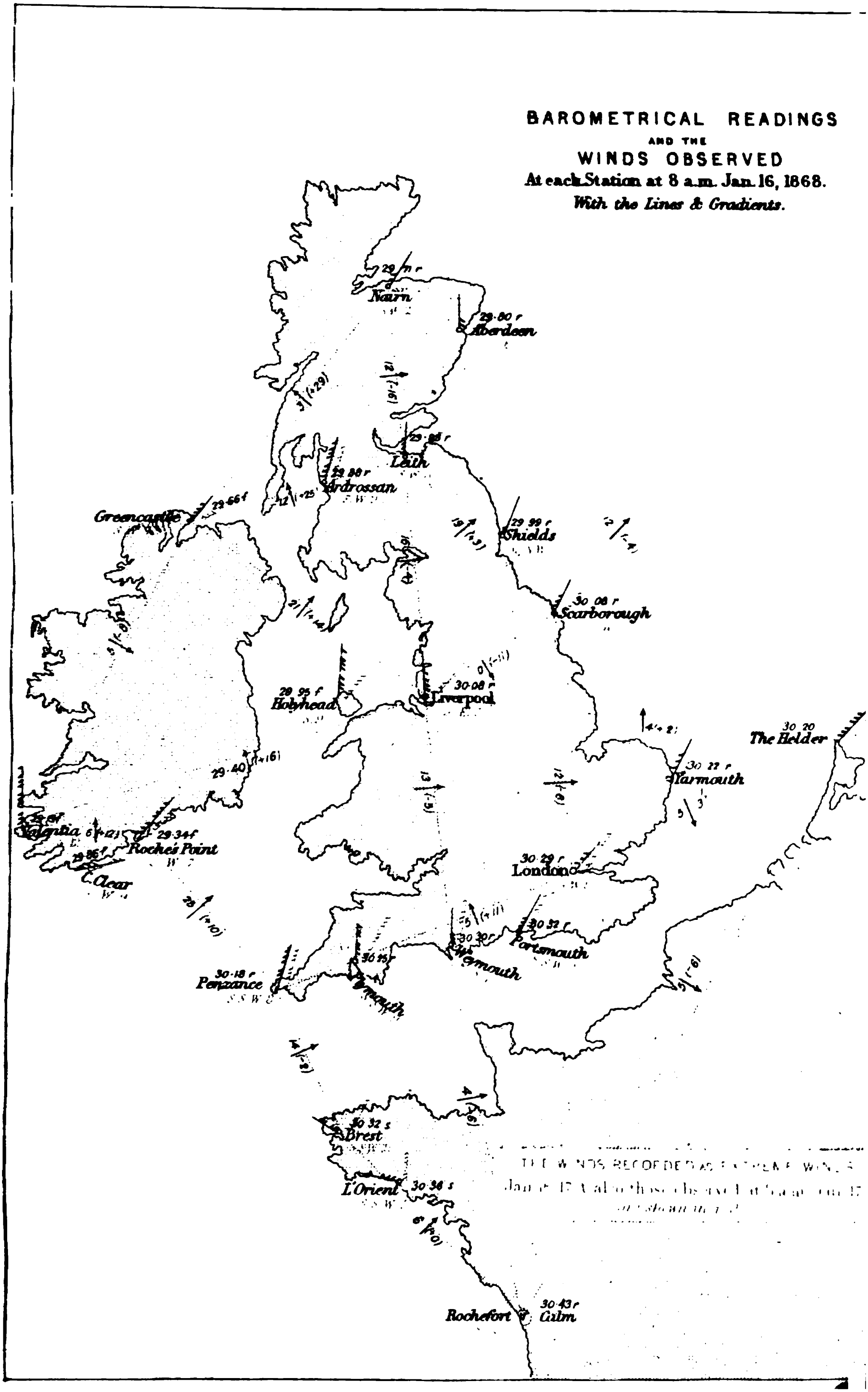
" The method adopted for testing the winds on each day will be understood by reference to the adjoining plate, which is reduced from the given map for January 16th, 1868, showing the barometrical readings and the wind at the various stations at 8 a.m., with the gradients and their changes during the preceding twenty-four hours.

" It will be seen from these that the area has been, so to speak, triangulated, as well as the situations of the reporting stations will allow. By this means we have got a large number of lines of variable lengths, running in different directions. Perpendiculars are let fall on each of these lines, and the direction of the lines are taken according to the approximate compass bearings of these perpendiculars, which are the wind directions indicated, according to the Law, by differences of barometrical readings at the extremities of the respective lines.

" In order to render the results obtained from lines of different lengths strictly comparable with each other, they have been reduced to one uniform standard of 100 miles. The actual length of each line, and the factor requisite to reduce its indications to those of the uniform standard length, and also the directions for the two winds indicated according as the barometrical reading at one end of the line is higher or lower than at the other, are here subjoined. These directions, of course, differ by 180°.

Bearing of Perpendicular.	Line.	Length in Miles.	Factor.	Indicated Wind.
W. 30° N.	Valencia to Greencastle	236	$\frac{2}{5}$	E.S.E. or W.N.W.
W. 40° N.	Greencastle—Nairn	180	$\frac{5}{9}$	S.E. „ N.W.
N. 30° W.	Greencastle—Leith	144	$\frac{5}{7}$	S.S.E. „ N.N.W.
E. 10° N.	Leith—Nairn	100	1	E. „ W.
E.	Liverpool—Leith	156	$\frac{5}{8}$	E. „ W.
E. 40° N.	Liverpool—Greencastle	189	$\frac{1}{2}$	N.E. „ S.W.
N. 30° W.	Liverpool—Scarborough	110	1	S.S.E. „ N.N.W.
W. 40° S.	Scarborough—Leith	131	$\frac{3}{4}$	N.E. „ S.W.
W. 40° S.	Helder—Nairn	394	$\frac{1}{4}$	N.E. „ S.W.
N. 30° E.	Heligoland—Nairn	445	$\frac{2}{9}$	N.N.E. „ S.S.W.
S. 10° E.	Heligoland—Liverpool.........	380	$\frac{1}{4}$	N. „ S.
N. 10° E.	Helder—Liverpool	284	$\frac{1}{3}$	N. „ S.
N. 30° W.	Heligoland—London	330	$\frac{3}{10}$	S.S.E. „ N.N.W.
N. 30° W.	Helder—London	200	$\frac{1}{2}$	S.S.E. „ N.N.W.
W. 30° N.	Heligoland—Rochefort	600	$\frac{1}{6}$	E.S.E. „ W.N.W.
W. 30° N.	Helder—Rochefort	480	$\frac{1}{5}$	E.S.E. „ W.N.W.
W. 10° S.	Weymouth—Liverpool.........	172	$\frac{3}{5}$	E. „ W.
W. 10° S.	Rochefort—Weymouth	287	$\frac{1}{3}$	E. „ W.
W. 10° S.	London—Scarborough.........	175	$\frac{4}{7}$	E. „ W.
N. 20° W.	Penzance—London	220	$\frac{4}{9}$	S.S.E. „ N.N.W.
N. 45° E.	Rochefort—Brest	200	$\frac{1}{2}$	N.E. „ S.W.
W. 20° S.	Brest—Penzance	101	1	E.N.E. „ W.S.W.
N. 45° E.	Brest—Valencia	307	$\frac{1}{3}$	N.E. „ S.W.
N. 45° E.	Penzance—Roche's Point ...	138	$\frac{5}{7}$	N.E. „ S.W.
N. 10° E.	Valencia—Roche's Point......	82	$\frac{5}{4}$	N. „ S.
N. 20° W.	Valencia—Liverpool...........	287	$\frac{1}{3}$	S.S.E. „ N.N.W.

" These factors are, as will be seen, merely the nearest simple fractions to the proportions between the length of each line and the standard length.



BAROMETRICAL READINGS AND THE WINDS OBSERVED At each Station at 8 a.m. Jan. 16, 1868. *With the Lines & Gradients.*

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ASTOR, LENOX AND
TILDEN FOUNDATIONS.

Date.	Gradient.		Line.	Winds. Extreme.	Winds. Next Morning.
Jan. 16	S.S.E. 12	+25	Leith—Greencastle -	S.W. 9, Ardrossan.	—
				S.W. 8, Leith.	—
	S.W. 21	+14	Liverpool-Greencastle	S. 9, Holyhead.	—
				S.W. 9, Ardrossan.	—
	S.W. 12	— 4	Helder—Nairn - -	S.W. 8, Leith.	—
	S.W. 19	+ 3	Scarborough—Leith -	W. 8, Yarmouth.	—
	S.W. 25	+10	Penzance-Roche's Pt.	S. 12, Valencia.	—
	W.S.W. 14	— 2	Brest—Penzance - -	S.W. 9, Cape Clear.	—
				S.S.W. 8, Penzance.	—
				S.S.W. 9, Plymouth	S.W. 9, Plymouth.
	W. 12	—16	Leith—Nairn - - -	S.W. 8, Leith.	—
	W. 16	— 4	Liverpool—Leith - -	S.W. 9, Ardrossan.	—
	W. 13	— 6	Weymouth-Liverpool	S.S.W. 8, Portsmth.	—
				S. 8, Weymouth.	S.W. 8, Portsmouth.
				S. 9, Holyhead.	—
	W. 12	— 6	London - Scarborough	S.W. 9, London.	—
				W. 8, Yarmouth.	—

Date.		Wind.		Station.	Preceding Gradient.		Line.
Jan. 16	Evening	S.	8	Holyhead - -	S.W. 21	+14	Liverpool—Greencastle.
		S.	12	Valencia -	S.W. 25	+10	Penzance—Roche's Point
		S.S.W.	8	Penzance -			
		S.S.W.	9	Plymouth -			
		S.	8	Weymouth -	S.S.E. 5	+11	London—Penzance.
		S.S.W.	8	Portsmouth-			
		S.W.	8	Leith - -	S.S.E. 12	+25	Leith—Greencastle.
		S.W.	9	Ardrossan -			
		S.W.	9	Cape Clear -	S.W. 25	+10	Penzance—Roche's Point
		S.W.	9	London -	W. 12	— 6	London—Scarborough.
		W.	8	Yarmouth -			
17	Morning	S.W.	9	Plymouth -	W.S.W. 14	— 2	Brest—Penzance.
		S.W.	8	Portsmouth-			

"This shows us that the only gradient exceeding 0·12 on the 16th, which was not followed by a very decided fulfilment, was that of West 13 from Weymouth to Liverpool. The predominating storms on the South coast of England were Southerly, and had very little Westing in them. They gave, however, abundant indications of their approach in the change of gradient of (+ 11) in the direction S.S.E. from London to Penzance.

"On the whole it will be seen that on the morning of the 16th there was a gale at only one station, viz., South 10 at Valencia, and on the morning of the 17th there were only two, viz., S.W. 9 at Plymouth, and S.W. 8 at Portsmouth, while between these two dates gales were felt at 10 stations, which might reasonably have been foreseen by an examination of the morning reports of the 16th, on the principles laid down in the preceding pages.

(41.) What has been said previously, as to the Isobaric Lines and Barometric Gradients, refers exclusively to the observations made and collected read 29·87, on the 19th 29·78, fall in the 24 hours 0·09. The barometric difference between the stations on the 18th was ·14, on the 19th ·16. If, then, the barometer at the ship, on the 18th, off Dover, read 29·87, and off Portsmouth on the 19th, 24 hours afterwards, 29·94, the captain would record a *rise* of 0·07, the barometer having really *fallen* 0·08 at a point intermediate between the stations: thus, while a *real* gradient of + ·142 existed between Dover and Portsmouth on the 19th, *the barometer having fallen at both stations during the previous 24 hours*, a captain sailing from Dover to Portsmouth during the same 24 hours would record an *apparent* gradient of + ·062, the *reduction* from the *real* gradient arising from the *fall* of the barometer at *both* stations, while the *rise* of his barometer resulted from his sailing toward the region of higher pressure."*

3.—NORTH ATLANTIC WINDS AND WEATHER.

(42.) The *Wind Regions* of the North Atlantic Ocean may be thus defined:—To the North of the Tropic of Cancer are the *Anti-Trades*,† or *Passage Winds*, which, though variable, have a general tendency from S.W. to N.E.; in these temperate and Arctic regions the general barometric pressure is moderate, with occasional appearances of areas of high pressure. South of these is a belt of Calms and Variable Winds, distinguished by a high barometer, called by Commander Maury the "*Calms of Cancer*," also known to sailors as the "Horse Latitudes," as hereafter explained. This belt varies between 30° and 35° N., according to the season. South of this, and extending to about 8° to 5° N., but varying in its Southern as in its Northern limits, is the great region of the *N.E. Trades*. In the space between the Equator and this region of Trades are the "*Doldrums*," or Calms, of the Equator; and upon the African coast there is a regular alternation of the winds, similar to the monsoons in other parts. Each of these regions will be treated of separately in the following pages.

(43.) In the spaces which separate these wind systems those storms known as Hurricanes, Tornados, Typhoons, or Cyclones occur. This important branch of the present subject is fully considered hereafter, but the occurrence of storms is an exceptional case in the vast system of atmospheric circulation we have been considering.

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* Those wishing further information on this subject should refer to a Paper on "Barometric Gradients in connection with Wind Velocity and Direction at the Kew Observatory," by G. M. Whipple and T. W. Baker, in the Quarterly Journal of the Meteorological Society, 1882, pp. 198—203.

† The term "Anti-Trades," adopted by Sir John Herschel, is expressive and appropriate. By others they have been named *Counter-Trades*, which designation may more exactly define the upper currents *over* the Trade Winds. They have also been vaguely called "The Variables," a term which is best confined to the characteristic of the Belts of Calm or shifting winds about the Tropics.

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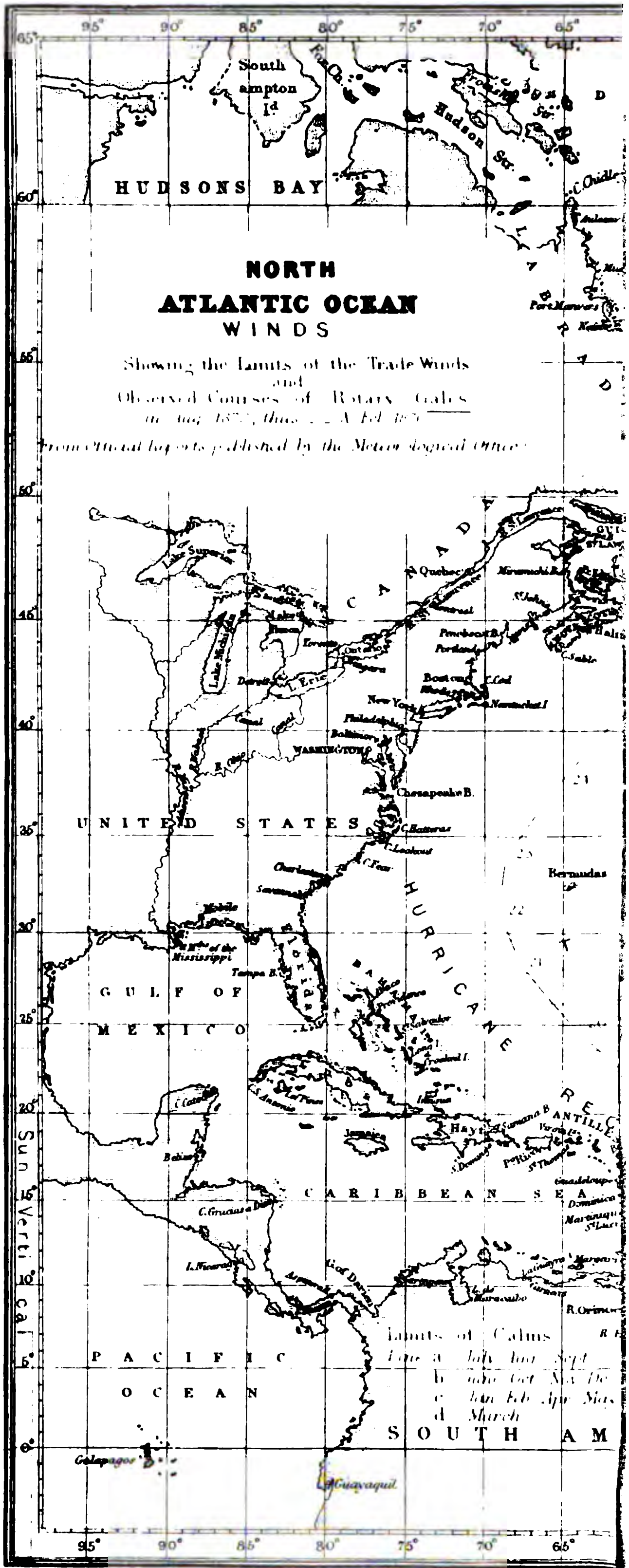

NORTH ATLANTIC OCEAN
WINDS

Showing the Limits of the Trade Winds
and
Observed Courses of Rotary Gales
in Aug 1873, thus [illegible] & Feb 187[illegible]
From Official Reports published by the Meteorological Office

Limits of Calms
a June July Aug Sept
b [illegible] Oct Nov Dec
c Jan Feb Apr May
d March

A G Findlay del.

June 21

July 23

Sun Vertical

Aug 23

Sep 23

(44.) **Wind and Weather Charts, &c.**—As before stated, it is to Captain Maury that the credit is due for initiating the system by which data from ships' logs are collected and formulated on the Meteorological Charts now published by our own and foreign nations. Captain (then Lieutenant) Maury's "Pilot Charts" were published in 1849, and were republished in a different form, in 1855, by our own Meteorological Department, under the direction of Rear-Admiral FitzRoy, and by the Royal Netherlands Meteorological Institute, which has done so much for the advancement of this knowledge. Since that time a great impetus has been given to these researches by the gratuitous labours of innumerable commanders of vessels, and others, who have kept carefully-compiled logs specially for the use of the various meteorological institutions, on which the more recent publications are based.

Among the more noted of these works may be mentioned those of our own Meteorological Office, including the "Synchronous Weather Charts of the North Atlantic and the adjacent Continents, from August 1st, 1882, to September 3rd, 1883;" "Wind and Current Charts," by Lieutenant Brault, of the French Navy, 1880; "Daily Synoptic Weather Charts of the North Atlantic Ocean, &c.," published by the Danish Meteorological Institute and the Deutsche Seewarte (a continuation of the work commenced by the late Captain Hoffmeyer, of the Danish Navy); the Charts accompanying the Report on Atmospheric Circulation, based on the Observations made on board H.M.S. *Challenger*, 1873—1876, and other Meteorological Observations, by Alexander Buchan, M.A., LL.D., 1889; "Atlantischer Ozean. Ein Atlas von 36 Karten, die physikalischen Verhältnisse und die Verkehrs-Strassen darstellend, mit einer erläuternden Einleitung," published at Hamburg by the Deutsche Seewarte, 1882; and last, though not least, the valuable "Meteorological and Pilot Chart of the North Atlantic Ocean," issued monthly by the United States Hydrographic Office, Washington.

(45.) Still, after all, but little has been done by these laborious researches towards showing the mariner what weather, &c., to expect *with certainty* in any particular district outside the Trade Wind regions, or as to the course of, and area covered by, disturbances he may meet with. In one passage favourable winds may be met with, and in the next passage at the same season nothing but head winds and bad weather may be experienced. The Weather Charts show with precision what has occurred, but what the future weather may be in the Northern part of the North Atlantic Ocean appears to be only a matter of chance. If it be difficult to forecast the weather ashore for only a few hours ahead, with all the appliances and advantages of a fixed observatory, how much more difficult must it be when dealing with a solitary vessel on the wide ocean.

Space will not allow us here to enter into the interminable discussions connected with this subject, even were it of much practical use to do so. Many more years of patient observation are necessary before any system can be hoped to be evolved from such discussions. All we can do in this work is to show, for the guidance of mariners, the results of what has hitherto been effected, while the student must refer for full details to the works already quoted, and others too numerous to mention.

(46.) We here give the Monthly Forecasts appearing on the United States Pilot Chart of the North Atlantic Ocean, and afterwards proceed to describe the Wind Regions enumerated in the opening paragraph (42) of this Section, commencing with the Trade Wind.

January.—Stormy weather will prevail over the Northern part of the North Atlantic and along the American coast North of Hatteras. Strong Westerly and North-Westerly gales may be expected every five or six days along the transatlantic steamship routes, accompanied by heavy snow-squalls and followed by clear and very cold weather. In the Gulf of Mexico severe Northers will occur as often as once in ten days, and Northerly gales may be encountered occasionally in the Caribbean Sea. The N.E. Trades will reach their extreme Southern limit. Fog will be encountered more frequently than during December on the Grand Banks and off the coast to the Westward, and Ice may reach South of the latitude of Cape Race, especially toward the end of the month.

February.—Stormy weather is likely to prevail off the American coast and over the Atlantic generally North of the 35th parallel, where fresh to strong gales, principally from the Westward, will be encountered about once a week. Northers will occur less frequently in the Gulf of Mexico, but may still be of great violence. Icebergs and field-ice may be encountered off Newfoundland and over the Grand Banks. The regions of frequent Fog are over the Grand Banks and George's Shoal.

March.—The weather on the North Atlantic will be considerably less severe than during February, the average Southern limit of the region of frequent gales being a line from about Hatteras to the English Channel. To the Northward, gales may occur as often as once in six days. Along the coast of the United States, from Hatteras Southward, the winds will be variable. Northers will be less frequent in the Gulf of Mexico, but may be fiercer on their first day and have less North-Westing in them. The N.E. Trades will be somewhat weaker than in February. Icebergs and field-ice have been encountered in March as far South as the 40th parallel, between the 41st and 55th meridians. Fog will be encountered with increasing frequency off the Grand Banks and the coast to the Westward.

April.—Westerly winds, of less force, however, than during March, will prevail over the transatlantic steamship routes East of the 60th meridian; West of that meridian, and along the Atlantic coast of the United States, the winds will be variable. Gales may be expected about once a week North of the 32nd parallel. Fewer Northers will be felt in the Gulf, and those that do occur will not last so long as earlier in the season. The N.E. Trades, having reached their Southernmost point, will now begin to extend farther North. Probably very little or no Ice will be encountered this month South of the 45th parallel. Considerable Fog will be experienced off the Grand Banks and along the coast as far South as Hatteras.

May.—Fair weather will prevail generally over the North Atlantic, with occasional Northerly gales along the American coast, and moderate North-Westerly gales along the transatlantic steamship routes, North of the 40th parallel. Northers in the Gulf of Mexico will occur less frequently and will not last long, but are liable to be of great violence. There will be a notable increase of Fog off the Grand Banks, due to the Northward movement of the Gulf Stream and the Southward extension of Ice brought down by the Labrador Current. Icebergs and field-ice may be encountered as far South as the 43rd parallel, between the 46th and 50th meridians.

June.—Generally fair weather will prevail, with occasional gales along the transatlantic route and off the Atlantic coast of the United States. West Indian Hurricanes which occur as early as June originate, generally speaking, in lower latitudes than later in the season, and are most liable to recurve in the belt from latitude 20° to 23° N. Considerable Fog will be encountered off the Grand Banks and the coast to the Westward as far South as Hatteras, and also in the vicinity of the British Isles. Icebergs and some field-ice may be encountered between the Grand Banks and the 45th meridian, as far South as the 43rd parallel.

July.—Generally fair weather will prevail. Occasional moderate gales, frequently accompanied by electric phenomena, will be felt North of the 40th parallel; and West Indian Hurricanes are apt to occur, especially during the latter part of the month. Frequent Fogs may be expected over the Grand Banks, off the American coasts North of Hatteras, as well as in mid-ocean, along the transatlantic route. Icebergs may be encountered to the Southward and Eastward of the Grand Banks, possibly as far South as the 41st parallel.

August.—Fair and exceptionally fine weather may be expected generally over the Atlantic this month. The principal danger will be from Hurricanes, and navigators should watch carefully to avoid them, if possible, or at least meet them to the best advantage. August, it should be remembered, is the principal Hurricane month. (Full directions are given in the Section dealing with them, for the best action to be taken on encountering one of these dangerous storms). There will be considerable Fog over and Westward of the Newfoundland Banks, as far as the American coast, but it will be less frequently met with than during July. Only a few bergs and little or no field-ice will be encountered off the Grand Banks.

September.—Moderate or fair weather may be expected, with occasional gales North of the 35th parallel and between the coast of the United States and Bermuda. West Indian Hurricanes are very likely to occur, and should be prepared for. There will be less Fog along the transatlantic steamship routes, and little or no Ice will be encountered off the Grand Banks.

October.—Generally moderate weather will prevail, but gales may be experienced along the transatlantic route and off the American coast three or four times during the month. Although October is the last month of the West Indian Hurricane season, several of the most severe Hurricanes on record have occurred about this time, and no precaution should be neglected. It will be well to remember that October Hurricanes recurve in lower latitudes, generally speaking, than during July and August. There will be less Fog than during September, and no Ice will be encountered South of the latitude of Cape Race.

November.—The West Indian Hurricane season is now at an end, and the gales that are encountered with increasing frequency North of the 40th parallel are mostly from the Westward and North-Westward. During the winter months the usual track of storms is Eastward across the Northern United States and Canada, and then about E.N.E. over the Atlantic, where they are followed by severe and long-continued Westerly gales. Probably no Ice will be encountered South of the latitude of Cape Race. Fog will be less frequent, owing to prevailing North-Westerly (off-shore) winds. Strong Northers are likely to occur in the Gulf of Mexico.

December.—The region of frequent and severe storms over the North Atlantic this month lies almost entirely to the Northward of a line from Bermuda to the Azores, the great pathway of winter storms being a belt about 500 miles wide stretching E.N.E. from Newfoundland toward and to the Northward of the British Isles. Very heavy Westerly gales follow the storms which move rapidly Eastward along this belt. Danger from Fog, however, is at its minimum, as the warm water of the Gulf Stream is well to the Southward, and dry off-shore winds prevail on the Grand Banks, and off the coast of Nova Scotia. Little or no Ice will be encountered. In the Gulf of Mexico, Northers become more frequent. The N.E. Trades are fresh and steady, sometimes interrupted in the Caribbean Sea by strong Northerly gales.

4.—THE NORTH-EAST TRADE WIND.

(47.) The regions of the Trade Winds occupy nearly one-half of the entire surface of the globe. From their constancy and regularity they form by far the most important part of the circulatory system of the atmosphere, although generally their strength is inferior to many of those smaller but compensating currents which are experienced in extra-Tropical regions.

(48.) The primary source from which the ensuing *statistics* of the Winds are chiefly derived is the extensive collection of observations recorded in the *Pilot Charts* of Lieutenant M. F. Maury, U.S.N., published in 1849. On our Chart of the North Atlantic Ocean, in four sheets, to which this work especially refers, these wind records are also arranged in a simple and comprehensive graphic form. In 1876 the Meteorological Office issued an analysis of the Meteorology of the Equatorial Region of the Atlantic, between lat. 20° N. and 10° S., and long. 10° to 40° W. This elaborate work, produced by Captain Toynbee, F.R.A.S., F.R.G.S., is chiefly derived from data collected by the late Admiral FitzRoy, and may be said to supersede the above-mentioned work of Lieutenant Maury, or that part of it which relates to the crossing of the Equator. We give farther on, Captain Toynbee's remarks on the Winds observed in this region.

(49.) **The North-East Trade Wind** blows over the Tropical region between lat. 36° N. and the Equator, seldom, however, reaching these extremes. When uninterrupted by gales or hurricanes, caused by the disturbing influences of land or rain, it is a fair weather region which procured for it the term of "The Lady's Gulf," by the old Spaniards. From the difference 0·055 inch in the observed mean barometric pressure by the Dutch in the N.E. and S.E. Trades, between the parallels of 5° and 20°, which is 29·968 inches for the former, and 30·023 inches for the latter, it was inferred by Captain Maury that the greater pressure in the S.E. Trades indicates a greater force and velocity* than the N.E. Trades. This, as investigated by him, was confirmed by the daily rate of vessels passing through them. He compared the sailings of 2,235 vessels, and found that the homeward-bound vessels crossed the Trades of the North Atlantic with the wind abeam at an average rate of 5·6 knots per hour, and across the Trades of the South Atlantic at an average rate of 6 knots. As the latter is with the wind generally dead aft, he argued that this rate would be increased 2 or 2½ knots with the wind on the beam, and make the difference still more evident. The comparative duration of each of these winds in the Atlantic is thus given by Captain Maury:—

Between Latitudes	N.E. Trades.		S.E. Trades.	
	Mean Direction.	Annual Duration.	Mean Direction.	Annual Duration.
° °	°		°	
0 and 5	N. 48 E.	76 days.	E. 34 S.	308 days.
5 „ 10	N. 46 E.	118 „	E. 41 S.	329 „
10 „ 15	N. 47 E.	208 „	E. 37 S.	305 „
15 „ 20	N. 46 E.	197 „	E. 34 S.	253 „
20 „ 25	N. 43 E.	167 „	E. 34 S.	168 „
Means.	N. 46 E.	153 days.	E. 36 S.	272 days.†

(50.) The *Force* or *Velocity* of the Wind is an important element in these calculations, and Captain Maury's system was enlarged upon by Lieutenant J. C. de Brito, of the Portuguese Royal Navy, who investigated the rates of sailing of 1,548 tracks across the Atlantic, and arrived at some important and unexpected results, differing in some degree from the conclusions of the great American meteorologist.

Lieutenant de Brito reduced the courses of all his ships to the most favourable point of sailing for all ships, that is, with the wind *free*, and took the months of February and March for one season, and those of August and September for the opposite. His enquiries related to both Trade Winds—the S.E. as well as the N.E.

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* It is generally argued, that less barometric pressure indicates increased force of wind, and not the reverse, as it is here argued; but from the following note it will be seen that these pressures are more nearly alike than is stated above.

† As this Table is founded on the assumption that the Equator is the division between the two wind systems, instead of the parallels of 5° to 9° N., as is really the case, it cannot be taken as a fair comparison of their relative duration. If the parallel of 5° N. be taken as a division, the mean barometric pressure in the N.E. Trades is 30·057 inches, and in the S.E. Trades 30·084 inches, making the latter the least. If the winds recorded between 0° and 5° N. be added to the S.E. Trades, it will give a mean duration of 239 days, and make the N.E. Trades 172 days.

(51.) For the N.E. Trade he had 803 tracks—424 Dutch, and 379 American. The region of this Trade he divided into *four* parts, viz. :—1. The *Eastern*, or that frequented by ships going South and passing to the *Eastward* of the Cape Verde Islands. 2. The mean route of vessels going South and passing *Westward* of those islands. 3. The *Central* part, containing the routes to the Southward of ships from Europe and America. 4. The part containing the *Westernmost homeward routes* of American vessels.

For February and March, he found that—

1. *East* of the Cape Verdes, the mean rate of 20 vessels, from 30° N. to 5° N., was 6·1 miles.
2. *West* of the Cape Verdes, the mean rate of 71 vessels, from 30° N. to 5° N., was 6·3 miles.
3. For the *Central* part, the mean rate of 262 vessels, from 25° N. to 5° N., was 6·5 miles.
4. For the *Westernmost* route, 44 American ships sailing from the Equator to 25° N., between long. 32° and 33° W., gave a mean rate of 6·7 miles.

Hence, for the whole region of the N.E. Trade, during February and March, the *Mean Rate* was 6·4 miles.

For August and September, when the N.E. Trade is weakest, and is in its most Northern position—

1. *East* of the Cape Verdes, the mean rate of 18 vessels, from 30° N. to 15° N., was about 6·3 miles.
2. *West* of the Cape Verdes, the mean rate of 155 vesssls, from 30° N. to 15° N., was 6·5 miles.
3. For the *Central* part, the mean rate of 198 vessels, from 30° N. to 15° N., was 5·3 miles.
4. On the *Westernmost* route, 35 American homeward-bound vessels, from 10° N. to 30° N., gave a mean rate of 4·8 miles.

And for the whole region of the N.E. Trade, during August and September, the *Mean Rate* was 5·7 miles.

For the strength of the S.E. Trade, there were 655 tracks—417 Dutch, and 238 American; and the regions given are :—1. The *Western*, in which the vessels go *Southward*. 2. The *Central*, in which the ships are coming from the East Indies.

During August and September, it appears that—

1. For the *Western* route, 232 vessels gave a mean rate of 7·5 miles.
2. For the *Central* route, 124 vessels gave a mean rate of 7·4 miles.

During February and March, the results are as follows—

1. For the *Western* route, 142 vessels gave a mean rate of 7·0 miles.
2. For the *Central* route, 157 vessels gave a mean rate of 7·1 miles.

The *S.W. Monsoon* region gives, according to 90 Portuguese ships, an average rate of 4·9 miles for February and March; and 5·3 miles for August and September.

(52.) From these observations it appears that the N.E. Trade undergoes, in the two epochs, considerable change of strength, viz., equal to 0·7 mile in favour of the February and March period; on the other hand, the S.E. Trade is stronger by 0·4 mile in the August and September period than during that for February and March.

Comparing the two Trades (N.E. and S.E.) together, it would seem that the S.E. is 1·2 mile stronger than the N.E.

Again, ships bound to the Southward may generally expect to find the N.E. Trade stronger on the *Central* route, during February and March, than more to the Eastward; while in the August and September epoch, they will find this wind blowing with its greatest intensity between the meridians of 20° and 25° W.

This last observation deserves consideration, because it is generally believed that the wind is stronger in proportion as the distance from the African shore is increased.

(53.) The N.E. (like the S.E.) Trade Wind, blows over a wider area in the Eastern part of the Atlantic than on the American side, as at the meridian of 10° W. they extend from 35° or 38° N. to 25° or 28° S.; while on the American side the limits are from 28° or 30° N. to 23° or 25° S.; but on the Eastern side the intervening space of Calms is much wider. The extent and limits will be best comprehended by an inspection of the diagram of the Winds; the limits there shown are taken from the tabular statements by Commander Maury and by the Dutch Meteorological Institute, and for the Equatorial region by Captain Toynbee. This will explain the various lines and fluctuations better than a long series of words.

The *Northern Limit* of the N.E. Trade Wind, as will be seen, extends on the Eastern side of the Atlantic, that is off the coast of Africa, to lat. 35° as a mean, in August and September, being then at its greatest Northern extent; but it is frequently encountered when in lat. 38°, or sometimes even at 40°. To the Westward of the meridian of 30° the Northern edge seldom extends Northward of 33° or 34°, while toward the Bahamas the Northern limit is 30° N. This extreme Northern declination appears to be attained in August and September, as stated before, and then following the sun in its southward course, it reaches its Southern limits in March or April. In January, its mean limit on the Eastern side is about the Canaries; over the Eastern half of the Atlantic in about 25° N.; in the centre about 22° N.; and over the Bahamas it seldom vibrates to any great extent throughout the year.

The extent of variation between the Northern edge of the Trade Winds when first encountered, as shown by Maury's Trade Wind Charts, seems to be as much as 10 degrees of latitude—a wide range of probability—and in many cases there appears from these charts to be as much chance of meeting them in one latitude as another. Of course this is taking into account the Belt of Calms and Variable Winds usually (but not always) found on the edge of the Trades, which will be spoken of presently.

(54.) The *Southern Edge of the N.E. Trade Wind* is limited in the Eastern part by that broad region so embarrassing to the sailor, known as the "Doldrums," or, especially during the Northern summer months, by a set of winds blowing towards the coast of Africa, known of old as the

West African S.W. Monsoon. This wedge-shaped area, whose apex reaches in July to 40° or 45° W., extends on the African coast at that period from 5° N. to 16° or 17° N. To the West of this there is still a belt of almost constant rain "under the Equatorial cloud ring," called the Equatorial Calms, which, however, is much narrower, and perhaps at times may not be encountered. The Trade Wind is at its Southerly limit in March and April, reaching in mid-ocean sometimes to 3° S., but seldom so far as 3° N. on the East side. It remains there for two or three months, and then advances Northward till August and September, when it is seldom found South of the parallel of 9° N.; indeed, this parallel may be taken as the mean Southern limit of the N.E. Trade. This Northern division of the Trade Winds is owing to the unequal distribution of land in the two Hemispheres.

The following useful Table was drawn up by the late Captain Horsburgh, as the limits usually found in the track generally pursued by the East Indiamen, at the commencement of the nineteenth century:—

TABLE, *showing the Equinoctial Limits of the N.E. and S.E. Trade Winds, between the Meridians of* 18 *and* 26 *degrees West.*

N.E. TRADE WIND.			S.E. TRADE WIND.		INTERVAL BETWEEN.
CEASES.	General Extremes. Lat N.	Probable Mean. Lat. N.	General Extremes. Lat. N.	Probable Mean. Lat. N.	Mean Breadth.
	° °	°	° °	°	°
In January at......	3 to 10	5	0½ to 4	2¾	2¼
February.........	2 to 10	4	0½ to 3	1¼	3⅓
March	2 to 8	4¾	0½ to 2½	1¼	3½
April	2½ to 9	5	0 to 2½	1¼	3¾
May	4 to 10	6½	0 to 4	2½	4
June...............	6½ to 13	8½	0 to 5	3	5½
July	8½ to 14	11	1 to 6	3½	7½
August............	11 to 15	13	1 to 5	3¼	9¾
September	9 to 14	11½	1 to 5	3	8½
October	7½ to 14	10	1 to 5	3	7
November	6 to 11	8	1 to 5	3	4¼
December	3 to 7	5½	1 to 4½	3¼	2¼

(55.). An inspection of the Weather Charts will show that at times the two Trade Winds are separated by only a very narrow belt of Calms, and vessels have even passed from one to the other without being becalmed for an hour. Thus, as before stated, it is impossible to state *certainly* where the Trade Winds will be met with or lost at various seasons. All that the charts and diagrams can do is to show their *probable* limits.

(56.) The *Direction of the N.E. Trade Wind* is an important nautical consideration. Its mean direction in the circuit of the earth is estimated at N. 47° E., but it varies considerably under the influence of the land, and especially so in the North Atlantic. As mentioned above, the Trade Wind blows much more from the Northward to the Eastward of long. 25° —that is, within 400 or 500 miles of the African coast,—than it does in

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Diagrams illustrating the direction of

THE N.E. TRADE WIND.

between Latitudes 10° & 20° N.

WEST

FIG. 1.

about the Cape Verde Iˢ

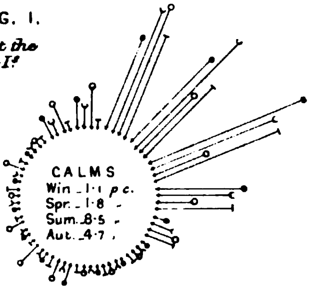


FIG. 2.

Long. 30°_40° W.

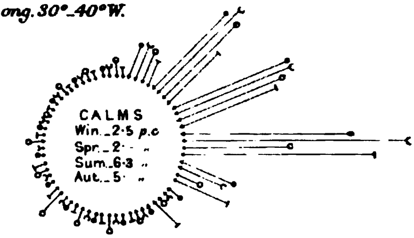


FIG. 3.

Long. 40°_50° W.

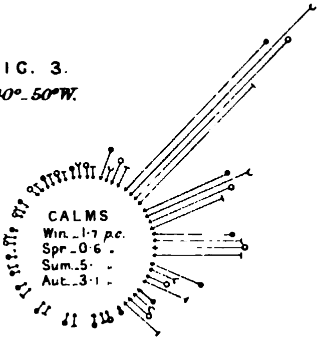


FIG. 4.

Long. 50°_60° W.

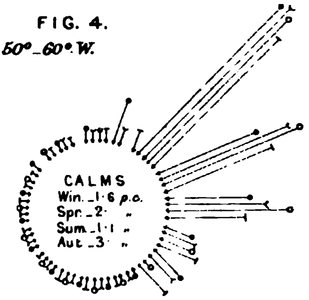


FIG. 5.

about the Windward Iˢ

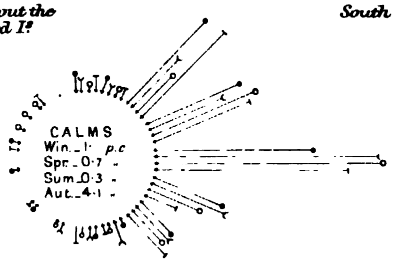
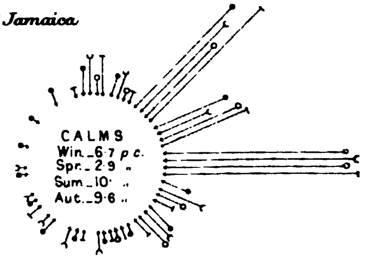


FIG. 6.

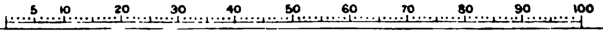
South of Jamaica



The arrows represent Winds *blowing toward the centre.*

•—— *Winter* {Jan. Feb. Mar. >—— *Spring* {Apr. May June o—— *Summer* {July Aug. Sep. ⊢—— *Autumn* {Oct. Nov. Dec.

The length of the arrows is proportionate to the frequency of that wind and the proportion per cent will be given by this scale.



SOUTH

R.H. Laurie, 35, Minories. London.

the open ocean. Between the Canaries and Cape Verde, during the Northern summer months, it blows from N.N.E. and N.E. for 55 days out of every 100 days.

During the winter months, from January to March, the wind in the neighbourhood of Cape Verde draws very much toward the land, or from N.W. and West. This point will be more fully discussed in a later part of this work.

(57.) In order more fully to exemplify the duration and direction of the Trade Wind, the adjoining diagrams have been selected from the Chart of the North Atlantic Ocean. They will show the particulars of the wind between the parallels of 10° and 20° N.; that is, in the main strength of the N.E. Trades. They have been adapted from Maury's Pilot Charts, as appeared before (48), and will show the per centage of winds from any quarter in each of the four *calendar* seasons; and also the amount per cent. of Calms encountered. The plate will explain the different arrows (indicating the seasons) which are supposed to represent winds blowing *toward* the centre of the circle, because the winds take their names from the quarters *from* whence they come, the *North* point being supposed to be at the top of the page, the South at the bottom, the East to the right, and the West to the left hand. The *length* of the uppermost arrows is proportioned to the duration or frequency of that wind, according to the scale attached; so that by applying the compasses to any one of the arrows, it will give, according to the scale, the amount of wind *per cent.* for that direction. These arrows are given for sixteen points of the compass, omitting the "by" points, in each season. The arrows altogether make up the length of 3 inches, that of the scale given.* In the centre of each diagram is given the amount per cent. of *Calms* encountered in the respective seasons. As the *Force* of the winds is not given in the Pilot Charts, this register of the Calms is the more important, as it is the only scale we can apply to the force of this wind; as, by analogy, we may argue that where Calms predominate, there also do light and baffling winds, and the reverse.

(58.) An analysis of the wind-roses in Captain Maury's Chart, from which these diagrams are constructed, will give the following figures as to the prevalence and direction of the winds along the main strength of the N.E.

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* There is one remark which it is necessary to make here respecting these wind observations (220,000 in number). They have been taken from a vast quantity of different log-books, whose remarks are not made with the definite accuracy necessary for scientific precision. A slight inspection of the figures given on the diagram, or of the Board of Trade charts, will show that in these data the direction of the wind is loosely and indefinitely given throughout. Thus, a wind between North and East is set down as a N.E. wind, &c., &c., and not so often as N.N.E. or E.N.E. as must really occur. Consequently, the arrows representing these principal or cardinal points are longer than they ought to be, and the intermediate ones shorter; in fact, they form a zig-zag or irregular curve around the centre; whereas it is manifest that this curve should be somewhat symmetrical, and that the wind blows from the intermediate points in some regular ratio to those on either side of it. Until we get more exact records added together in great numbers, as has been done in the Pilot Charts with these imperfect logs, it is plainly futile to draw any precise or refined conclusions from their teaching. This is not said to underrate their value. To the sailor, who only requires a general exact knowledge of the subject, they teach as much almost as he requires to know as to the direction of the wind.

Trades in the North Atlantic. It must be premised, however, that these figures, as well as the data from which they are derived, will give only a general view of the phenomena likely to be encountered, and the *chances* per cent. that a ship will have of meeting with similar winds or calms. The figures in these columns give the number of days (or observations) the wind blows in *each hundred*, from the respective directions :—

Fig. 1.—*In the neighbourhood of the Cape Verde Islands.*

	Between N. & E.	E. & S.	S. & W.	W. & N.	Mean.	Frequent.	Calms.
Winter	73	12	10	7	N.E.	E.N.E.	1·1
Spring	76	18	4	2	N.E.	N.E., N.N.E.	1·8
Summer	70	14	4	12	N.N.E.	N.N.E.	8·5
Autumn	63	22	6	9	N.E.	E.N.E.	4·7

Fig. 2.—*Between Lats. 10° and 20° N. and Longs. 30° and 40° W.*

Winter	45	41	2	2	E. by N. ½ N.	East.	2·5
Spring	48	48	2	2	E.N.E.	East.	2·0
Summer	48	32	12	2	E.N.E.	N.E. to E.	6·3
Autumn	32	51	9	2	E. by N.	East.	5·0

Fig. 3.—*Between Lats. 10° and 20° N. and Longs. 40° and 50° W.*

Winter	60	26	8	6	N.E. ½ E.	N.E.	1·7
Spring	70	25	0	5	N.E. by E.	N.E.	0·6
Summer	63	29	4	4	N.E. by E. ¾ E.	N.E.	5·0
Autumn	50	34	4	2	N.E. ¼ E.	N.E.	3·1

Fig. 4.—*Between Lats. 10° and 20° N. and Longs. 50° and 60° W.*

Winter	66	33	7	5	N.E. by E.	N.E.	1·6
Spring	65	30	2	3	N.E. by E. ½ E.	N.E.	2·0
Summer	63	31	4	2	E.N.E.	N.E., E.N.E.	1·1
Autumn	59	29	2	0	N.E. by E. ¾ E.	N.E.	3·0

Fig. 5.—*In the East Part of the Caribbean Sea, near the Windward Isles.*

Winter	42	46	0	2	E. by N. ½ N.	East.	1·0
Spring	35	63	2	0	E. ½ N.	East.	0·7
Summer	33	61	3	3	East.	East.	0·3
Autumn	44	51	2	3	E. by N.	East.	4·1

Fig. 6.—*In the West Part of the Caribbean Sea, South of Jamaica, &c.*

Winter	47	42	6	5	E. by N.	N.E., E.	6·7
Spring	42	50	8	0	E. by N.	East.	2·9
Summer	44	56	0	0	E.N.E.	East.	10·0
Autumn	54	43	3	0	E.N.E.	N.E., E.	9·6

(59). In examining the figures in these Tables, and the illustrative diagrams, it will be seen by Fig. 1, that about the Cape Verde Islands, or that part of the Atlantic most frequently crossed by vessels from Europe, the mean direction of the Trade Wind is to the Northward of N.E.; and further, that Calms and light airs are more prevalent than farther to the Westward, especially in the summer and autumn months, July to December. It has always been held that the wind draws more to the Eastward as you get to the Westward of the usual crossing of the Equator, and this an inspection of Fig. 2 will verify, when it is seen that the mean direction is South of E.N.E., and that the Calms, taking the year round, are less frequent.

Whether the Cape Verde Archipelago has an influence in thus causing the Trade Wind to assume a more Easterly direction to the Westward cannot very well be determined; but it is certain that this E.N.E. direction is not maintained between longitude 40° and the West Indies, as Figs. 3 and 4 show that winds hold persistently to the N.E., or a little to the South of it, although winds to the Northward of N.E. are very rare. It is probable, also, that the winds recorded from the other directions are exceptional.

The Easterly direction of the Trade Wind in the Caribbean Sea will be readily noticed. It will be further remarked on in the observations on the winds of the West Indies, hereafter.

(60.) The calendar seasons of Northern latitudes are here taken as the quarters of the year. In the American charts these seasons are made to include the month before the usual reckoning; thus, winter begins with December; spring, with March, &c. Perhaps the latter mode of division would be rather more applicable to the Tropical phenomena than that here chosen, because it appears that the changes in the inter-Tropical seasons (to which, however, the terms winter, spring, &c., are not applicable) seem rather to coincide with the American calculation. But as these changes are certainly not simultaneous in the Northern latitudes, and, as including such a difference would involve some confusion, the ordinary terms used to designate European seasons is here adhered to as being readily comprehended and sufficiently exact.

(61.) The following summary of Trade Winds was given by Commander Maury, in connection with his "Wind and Current Chart":—

"There is a marked difference in the prevailing direction of the wind, not only according to the season of the year, but also according to different parts of the ocean, including even those parts which are between the same parallels of latitude, but in different longitudes.

"As a general rule it may be remarked:—

"1st. That in the North Atlantic, the nearer to the coast of Africa and the Equator, the more the so-called N.E. Trade Winds haul to the South.

"2nd. That to the West of long. 45°, between 20° and 30° N., the N.E. Trades blow much more steadily in May, June, July, and September, than they do during the rest of the year; and that during the other months, particularly in March, they blow between these parallels nearly alike from all points of the compass.

"3rd. That between lat. 15° and 20°, they are most variable, West of long. 35°, in the months of September, October, and November; while to the East of 30°, between these parallels, they are most variable in February, March, April, and October.

"4th. That between lat. 10° and 15°, to the West of 35°, they are steadily between E.N.E. and S.E., except in July, August, September, October, and November, when they are more variable, being most variable in the three months first named. To the East of 35° W., between these parallels, they may be said to lose their Trade character during the months of July, August, September, and October, particularly in August and September, when they blow nearly alike from the four quarters. Calms, too, are more frequent here in these months.

"5th. That between the Equator and 10° N., to the East of long. 30°, the winds assume a new feature. It may be said, almost literally, that in this part of the ocean they uniformly blow, when they blow at all, during the months of July, August, and September, from some point between S.E. and West. They blow most between South and W.S.W., and very rarely from any point between North and E.S.E. To the West of this meridian, during the same months, they blow most between S.E. and N.E., inclining more and more to the North as you go West. These are the months in which the winds vary in this part of the ocean."

(62.) The following are Captain Toynbee's remarks which accompany the Monthly Charts* of the Prevailing Winds in the region of the Atlantic between lat. 20° N. and 10° S., and long. 10° to 40° W. In the chapter of this work devoted to Passages, some illustrations will be found, together with Captain Toynbee's remarks on the Best Route across the Equator.

January.—Since December the N.E. Trade has advanced about 2° to the Southward on the Western side of the district where it now prevails to the Equator; but on the Eastern side it holds much the same position as in December. On the Eastern side it falls lighter and draws more Northerly than it does farther to the Westward, while near to the African land it becomes very light and North-Westerly. It has decidedly increased in force since December. In Square 40 it is very squally and gusty, much more so than in the Squares to the Eastward, which is the more remarkable as Square 40 is open sea, whilst Square 39 contains the Cape Verde Islands. Perhaps the proximity of Square 40 to the area of high pressure may have something to do with it, as the gusts often come with a clear sky and with very little wind between them, as though they were the effect of downward rushes of dry air. Sharp gusts with blue sky, very cool weather, and the atmosphere very transparent, are often experienced at the Polar verge of each Trade.

The S.E. Trade only prevails to the Equator on the Western side of the district; to 4° N. in its central part; and there is a prevailing Southerly wind up to 8° N. on its extreme Eastern side, but it is very light, and the weather very unsettled. Near the Equator the S.E. Trade has very decidedly decreased in force since December.

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* "Meteorological Data for the nine 10° squares of the Atlantic, which lie between lat. 20° N. and 10° S., and extend from long. 10° to 40° W.," published by authority of the Meteorological Committee, 1876.

February.—The N.E. Trade has advanced nearly 2° to the Southward since January; it now extends to about 4° N. on the Eastern side, and to the Equator on the Western side of the district. It still falls light and becomes North-Westerly near the African land. Between 10° and 20° N. it has decidedly decreased in force since January, whilst between 0° and 10° N. its force has increased. It is still very gusty in Square 40°, and in some cases the gusts are strongest when the sky is clear, and are called "hard clear squalls."

The S.E. Trade prevails to 2° N. in the central part of the district, whilst on the Eastern side a light South-Westerly wind prevails between 4° and 6° N., where it is met by the light North-Westerly wind of the N.E. Trade. The S.E. Trade has decidedly decreased in force since January. In Square 302 there is frequent mention of squalls or sudden shifts of wind from S.E. to N.E., as though the upper current of air sometimes forced itself to the surface.

March.—The N.E. Trade holds much the same position in the central part and on the Eastern side of the district as in February, but it has advanced to the Southward of the Equator near South America. Its direction has become more North-Westerly on the Eastern side of the district than it was in February, where it also continues to be much lighter than on the Western side. It has decreased in force since February. Square 40 is still remarkable for having strong gusts of wind, and in some cases it is recorded that they are stronger with a clear than with a cloudy sky.

The S.E. Trade still prevails to 2° N. in the central and Eastern parts of the district, and a South-Westerly wind is found to prevail as far as 8° N. between 15° and 20° W., where it meets the prevailing North-Westerly wind of the N.E. Trade, both blowing towards the area of lowest pressure. It seems to have slightly increased in force since February.

April.—The direction of the N.E. Trade is very similar to that for March, it being still North-Easterly on the Western side of the district, Northerly between 20° and 25° W., and drawing into a light North-Westerly wind on its Eastern side, where it extends 2° more to the Southward than in March. Between 18° and 20° N. there has been but little change in its force since March, but to the Southward of that latitude it has decidedly decreased. Gusts of wind are rarely reported in Square 40, but puffs (a weaker kind of gust) were still very common, and much more frequent than in Square 39.

The S.E. Trade only prevails to 4° S. on the Western side of the district, but it extends to 4° N. on its Eastern side.

The prevailing South-Easterly wind shown between 8° and 10° N. on the Eastern side of the district is the result of only one observation, whilst the North-Westerly winds which surround it number thirty, so that North-Westerly winds may be supposed to prevail there. The S.E. Trade has slightly increased in force since March.

May.—The direction of the N.E. Trade is very similar to that of April, though rather more Easterly between 20° and 25° W.; its force has increased in the Northern part of the district, but decidedly decreased to the Southward of 10° N. It has generally receded fully 2° before the S.E.

Trade, but on the Eastern side it has given way 4°. The N.E. Trade is still much more gusty in Square 40 than in 39, and the gusts are sometimes heavy with clear weather. Gusts and puffs are also common in the Northern part of Square 4.

The S.E. Trade prevails to the Equator on the Western side, and a Southerly wind to 8° N. on the Eastern side of the district; besides gaining so much on the N.E., the S.E. Trade has decidedly increased in force since April.

June.—The direction of the N.E. Trade continues very similar to what it was in May, drawing into a North-Westerly wind near the coast of Africa. Its force has decidedly increased between 16° and 20° N., but decreased to the Southward of 16° N. It has generally receded 2°, and in some parts of the district 4° to the North. It is still much more gusty and puffy in Square 40 than in Square 39.

The S.E. Trade prevails to 6° N. except on the extreme Western side of the district; on its Eastern side South-Westerly winds prevail to 8° N., and even to 10° N. between 15° and 20° W. The S.E. Trade has very decidedly increased in strength since May.

July.—The N.E. Trade still draws more Northerly and eventually North-Westerly as it approaches Africa; its force has very decidedly decreased since June, and it has receded nearly 4° before the Southerly wind. In Square 40 it is very much more gusty than in Square 39, so much so that although Square 39 had nearly four times as many wind observations as Square 40, the number of gusts and puffs there is not nearly so great.

The S.E. Trade now prevails to 10° N., and there is a prevailing S.S.W. wind up to 12° N. on the Eastern side of the district; between 12° and 14° N. on the same side the prevailing wind is West, and to the Northward of that latitude North-Westerly. Having frequently passed from the Northward between the Cape Verde Islands and Africa in July, I can well remember the wind going from N.W. to West and S.W. as we sailed to the Southward. The July diagram gives a picture of the winds then sailed through. The S.E. Trade has increased in force since June, especially the Southerly winds to the North of the Equator.

August.—The N.E. Trade is still lighter, more Northerly, and in some cases North-Westerly near Africa. Its force has decreased since July, and it has receded about 2° to the Northward, its Southern limit being now in about 12° N., its most Northern verge for the year.

The S.E. Trade prevails to 6° N. on the Western side of the district, while the prevailing Southerly wind now extends to 14° N. on the Eastern side. On the Northern side of the Equator its force has very decidedly increased since July, but it has not changed much in the South. The S.E. Trade is more Southerly in Square 303 (near South America) as well as more squally and unsteady than in the Squares to the Eastward.

The diagram shows that between 14° and 8° N., North-Easterly and South-Westerly winds prevail in spaces which lie abreast of each other and in the same latitude, the N.E. being to the Westward of the S.W.; such a state of the atmosphere makes it probable that whirls revolving similarly to West India Hurricanes will be formed, and suggests that this is their birth place, which has been proved true in some cases.

September.—The N.E. Trade has generally increased in force, but is blowing in nearly the same part of the district as in August.

The Southerly winds North of the Equator continue to blow over the same part of the sea as in August; they also continue to draw into South-Westerly winds as they approach the area of lowest pressure near the West Coast of Africa; their force has very decidedly decreased since August. To the Southward of the Equator the S.E. Trade has decidedly increased in force since August. The gradient for North-Easterly winds seems to be steeper than for South-Easterly of the same force; this appears to be common in other months also, and probably indicates that the N.E. Trade gradient gets some of its supply of air from a downward movement, whilst that part of the S.E. Trade with which we are dealing is probably more entirely a horizontal motion of air. The dry, transparent, gusty nature of the Northern part of the N.E. Trade probably points to the same fact.

October.—The N.E. Trade has advanced several degrees to the Southward, especially on the Eastern side of the district, and now prevails to 8° N.; by this change it has extended over that part of the sea where there is the highest temperature of both air and sea, so that instead of North-Westerly and South-Westerly winds blowing into the area of highest temperature, there is a hot N.E. wind blowing from it! The N.E. Trade has increased in force since September.

The S.E. Trade prevails to 8° N., and there is no prevailing South-Westerly wind, it having given way to the N.E. Trade. The S.E. Trade has very much decreased in force since September, especially in the Southern part of the district. Easterly squalls, veering from N.E. to S.E., are very common between the Trades in October.

November.—The N.E. Trade has advanced about 2° to the Southward since October, and now prevails to 6° N.; it still extends over the hottest area of air and sea, and, as in October, has not that tendency to draw into a North-Westerly wind near the Coast of Africa which it had in previous months. In the most Northern part of the district it does become more Northerly near Africa, but in about 10° N. it becomes more Easterly again, and draws away from the land. The N.E. Trade has decreased in force near its Northern limits since October, and increased near its Southern limits; in the extreme North of the district the percentages of South-Easterly and South-Westerly winds have much increased since October, which seems to show that the Northern limit of the Trade is not very far North of the district in November.

The S.E. Trade prevails to 6° N., and, as in October, has fewer South-Westerly winds at its Northern verge than in previous months. South of the Equator it has increased in force since October, but scarcely changed to the Northward of it.

December.—The N.E. Trade has advanced 2° to the Southward since November, and now prevails to 4° N. Near the African land the wind again becomes light, and more Northerly, changing even to North-Westerly between 6° and 10° N., but the prevailing wind still blows North-Easterly, *from* the hottest air and sea. The most remarkable feature in the direction of the N.E. Trade in December is its prevalence at East between 10° and

20° N. and 25° to 30° W.; between 18° and 20°, 40 per cent. of the wind observations are from East, or some point to the Southward of East. It seems most probable that this remarkable difference in the direction of the wind is caused by the Cape Verde Islands, though it is difficult to say why they should not have a similar effect in some other month. The N.E. Trade has decidedly increased in force since November. Considering the number of wind observations in each Square, the percentage of gusty and puffy winds is much greater in Square 40 than in Square 39. Between 16° and 17° N. and 34° and 35° W. there were heavy squalls without either clouds or rain. Fine weather winds, and squally winds having a force 7 or upwards, are more common in Square 40 than in 39.

The S.E. Trade prevails to 4° N. It has very decidedly decreased in force since November.

Conclusion.—The N.E. Trade sometimes seems to draw round the Coast of Africa in the same way that water does round a rock, whilst the current arrows show that the sea has a similar motion. The Trade gets weakest in that part of the sea where the difference of temperature of both air and sea is greatest, which is contrary to the theory of some meteorologists. Sometimes it seems to blow from hot towards cooler air, as shown in the diagrams of October and November. The remarkable clear-weather gusts experienced in Square 40 have been remarked upon in the course of the Paper as probably downward rushes of air.

The "Remarks on Wind" show that both the N.E. and S.E. Trades are often more Easterly in direction and weaker in force during the night than during the day.

Attention has been called to the fact that in December, the commencement of the Harmattan season, the N.E. Trade is diverted into an East wind on the Western side of the Cape Verde Islands, whilst to the Eastward of them it blows from N.N.E. It has also been shown that during the Southern winter the wind and weather near Cape St. Roque are much more unsettled than they are in parts of the sea in the same latitude, but farther East; also that the wind becomes very Southerly near the South American Coast, whilst in the Southern summer it is very Northerly.

N. B.—It should be clearly understood that whilst the diagrams only show the wind from that point of the compass which has the largest number of observations, a great variety of other winds blow in those parts where the two Trades meet, especially in the atmospherical eddy which curves round the South-Western part of North Africa; into it the Northern verge of the S.E. Trade is drawn as a light South-Westerly wind, where it meets the Southern verge of the N.E. Trade drawn into a N.W. wind, and the result of their meeting is the greatest confusion of light airs, calms, squalls, rain, thunder, and lightning of the most awful kind, together with water-spouts, &c., &c.

To the foregoing general remarks the following, respecting particular localities within the scope of the N.E. Trade Wind, are added. Further application of them will occur in the Section on Passages, and other remarks will be found in the Descriptions of the Coasts and Islands.

(63.)—**Winds of the Atlantic Islands.**—The winds upon and near the different islands in the Atlantic Ocean are very variable and uncertain, especially where the land is high and irregular. In general, regular sea and land-breezes alternately prevail; the Sea-breeze by day and the Land-breeze by night, as the land is alternately heated and cooled; but the direction of these breezes is varied by the quality and figure of the land, and other local circumstances. If the land be very high, it generally intercepts the prevailing wind, and so affects the air as to produce, on the lee-side, either a calm, a gentle breeze in an opposite direction, or a kind of eddy, which is sometimes very troublesome to sailing ships. Such is the case under the Western part of Madeira, and to leeward of the Canary Islands. The Grand Canary is so high as to stop the current of the N.E. wind which prevails there; and on the Eastern side there is a calm, or a gentle breeze from S.W.

The calms and eddy winds, occasioned by the figure and height of the Canaries, extend from 30 to 90 miles beyond them to the S.W., according to the height of the respective islands. The boundary of the calms may be seen, for, within them, the water is smooth; without them is the regular undulation of the sea, caused by the general wind; and at the end of them, the winds, by setting in opposite directions, produce a breaking of the waves with a foam, like the billows on a rocky shoal just beneath the surface of the ocean.

From a consideration of the particulars now described, the cause of those copious dews which fall in the night on the islands, &c., situated within the Tropics, will be apparent. For as the great power of the sun by day causes an extraordinary evaporation of the water of the ocean, so, in the night, the exhalation, ceasing to retain the same degree of levity acquired from the heat of the sun, becomes, by the absence of the power which produced it, so dense and heavy as again to fall back to the earth. The air at the same time cooling, by the same cause, is also affected by the descending moisture, and thus acquires an additional tendency to increase the land-breeze.

(64.) **West Indies.**—The following description of the winds prevailing over these regions in general, in the different seasons, is taken chiefly from Captain Livingston's translation of the "Derrotero de las Antillas," or Spanish Directory for the West Indies.

On the Eastern coasts of Central America, and among its islands, the course of the general Easterly or Trade Wind is uninterrupted, though subject to some modifications in direction and force. At a short distance from the land the sea-breeze calms at night, and is replaced by the land-breeze. This variation happens every day, unless a strong wind prevails from the Northward or Southward; the first of these being experienced from October to May, and the second in July, August, and September.

The general Easterly wind, of the Tropical regions, is felt on the coast of Guayana, and on the coasts of the Caribbean and Mexican Seas, but with variations which may be denominated *diurnal* and *annual*. The diurnal period is that caused by the sea-breeze, which strikes the coast usually at an angle of two points, less or more, from a right angle, according to the locality and other circumstances; and then the land-wind, which, coming from the interior, always blows off shore. The sea-breeze comes on at about 9 or 10 in the forenoon, and continues while the sun is above the horizon, increasing its force as that luminary augments its altitude, and diminishing in a similar proportion as the sun's altitude decreases. Thus, when the sun is on the meridian, the sea-breeze is at the maximum of its strength; and at the time that the sun reaches the horizon this breeze has perceptibly ceased. The land-breeze commences before midnight, and continues until the rising of the sun, sometimes longer. A space of some hours intervenes between the land-breeze ceasing and the sea-breeze coming on, during which there is a perfect calm.

The *annual period* of the Trade Wind here is produced by the proximity or distance of the sun, which occasions the only two seasons known in the Tropics, the *rainy* and *dry* seasons. The first lasts from June to November, when the sun is in the Tropic of Cancer, and heavy rains with loud thunder are prevalent. In this season the wind is generally to the Southward of East, but interrupted by frequent calms, yet it occasionally blows with force, and the atmosphere is thick and cloudy.

When the sun removes to the Tropic of Capricorn, the dry season commences, and then the Trade Wind, which is steady at N.E., is cool and agreeable. At this season, North and N.W. winds are sometimes found blowing with much force; and, indeed, in some degree, they regularly alternate with the general wind, as they are more frequent in November and December than in February and March.

In the change of the seasons there is a remarkable difference; for in April and May no change is experienced in the atmosphere, and the weather is, in general, beautifully fine; but in August, September, and October, there are usually calms, or very light winds; and dreadful Hurricanes in these months sometimes render the navigation perilous. From these perils, however, are generally exempted the Island of Trinidad, the Coasts of Venezuela (the old Tierra Firma), the Bays of Darien and Honduras, and the Bight of Vera Cruz, which the Hurricanes seldom reach. In the space of sea between the greater Antillas (Cuba, Jamaica, Hayti, and Porto Rico), and the South American coast, the general N.E. or Trade Wind regularly prevails; but near the shore local peculiarities are found.

(65.) **Jamaica.**—At Jamaica the air is, in most places, hot and unfavourable to European constitutions; but the cool sea-breezes, which set in every morning, render the air more tolerable; and that upon the high grounds is temperate, pure, and cooling. It lightens almost every night, but without much thunder; nevertheless, when the latter happens, it is very terrible, and roars tremendously.

On the Northern side of the island the sea-breeze from the South-Eastward comes on in the morning, and gradually increases until noon, when it is strongest; at two or three in the afternoon its force diminishes; and, in general, it entirely ceases by five o'clock. About eight in the evening the land-breeze begins; this breeze extends to the distance of 12 miles to the Southward from the island. It increases until midnight, and ceases at about four in the morning.

The sea and land-breezes are more regular than otherwise from the latter part of January until May. In the middle of May the sea-breeze generally prevails for several days and nights, especially about the time of full and change of the moon; and thus they continue throughout June and part of July; from that time the sea-breeze diminishes, varies, and veers round to S. by W., or S.S.W., with frequent calms. August, September, and October, are the Hurricane months, in which there are generally strong gales of wind, with much rain.

In December, January, and February, when the North winds predominate, their force checks the sea-breeze. The Southern coast is that which, of course, is least exposed to these winds, being sheltered, in a great measure, by the mountains. When combined with the land-breeze, they render the air very cold and unhealthy.

During the months of July and August, the sea-breeze about the island generally blows impetuously, and in frequent squalls. At this season, vessels bound hence to Europe would have the most advantageous passage through the Strait and Stream of Florida; but in October Northerly winds frequently extend over all the Bahamas, Cuba, and for some time on the North side of Jamaica; but the current of air is forced upward by the mountains of the latter, and its strength is spent in the heights. In seasons when it is more impetuous, it rushes through the windings and defiles of the mountains upon the Northern Coast, particularly in the neighbourhood of Kingston, and has sometimes been known to continue for several days in succession.

During the winter the land-breeze is more general off the shores than in summer; it sometimes continues throughout the day as well as night; and Westerly winds prevail over all the space between Jamaica and Cuba, and even to the Island of Hayti or St. Domingo. They have been experienced from Port Royal, through the Windward Channel; but this is not generally the case.

In November, Southerly winds prevail on the South side of the island, and have been known to extend to the Mosquito Shore, whence vessels have arrived in five or six days, that might, at other times, have been as many weeks, when beating against the sea-breeze. The Southerly winds are generally faint; nor do they come upon the land until it be heated by the sun, and are often expelled by a fresh land-breeze soon after mid-day, which abates in a few hours.

The return of the sea-breeze, falling sooner or later in autumn, is gradual, first approaching at the East end, then advancing a little; and in some years it reaches Morant Point fourteen or twenty days before it is felt above Kingston. It also blows for a week or two later on the East end of the island than at Kingston; and has been known, in some years, to prevail there in the day time during the whole time it was unfelt at the former place.

(66.) At the *Cayman Islands*, summer winds range from E.N.E. to S.S.E. Rainy weather sets in about the middle of May and continues till August. Heavy squalls are prevalent from East and E.N.E., in June, coming on suddenly at or before midnight. From November to April, the direction of the wind is from N.E. to North, seldom varying for more than 48 hours. There is at that time very little smooth water, and landing is difficult. When the land winds are strong on the coast of Cuba, the swell rolls across and breaks heavily on the Northern shores of these islands.—*Lieutenant Carpenter, R.N.*, 1880.

(67.) **The Bahama Islands** are all within the influence of the Trade Winds. Their lowness, of course, exempts them from the regular land wind; but in the summer season a light breeze frequently comes from the Florida shore in the night, and reaches the Western side of the Little Bahama Bank, but no farther. At this period the wind generally prevails to the Southward of East, and the more so as their N.W. extreme is approached; the weather is then very variable, and squalls rush down with great violence, accompanied with heavy rains and an oppressive atmosphere. They are within the zone of Hurricanes, and a year seldom passes without their being visited by a heavy gale at least, from the S.E., which inflicts serious damage both on shore and at sea.

In the winter months, from about November till the middle of March, the Trade Wind is frequently interrupted by N.W. and North winds. In December and January this may be expected almost weekly. Previously to this change the wind will draw round to the South and S.W. In about twenty-four hours, or less, dark masses of clouds will be seen rising from the Westward, and in a short time the wind will rush down suddenly from that quarter with the force of a double or treble-reefed top-sail breeze. It will soon veer round to the N.W. and North, with clear weather, and remain between these points two or three days. It will then haul gradually to the N.E., perhaps with increased force, accompanied by heavy squalls, and wear itself out at East in the course of a few days. The barometer is scarcely any guide.

(68.) Among the local winds of the West Indies are the *Bayamos*, violent gusts which blow from the land on the South side of Cuba, and are so termed from being felt more severely off the *Bight of Bayamo* or *Buena Esperanza*, than off any other part of the coast.

When heavy and dense clouds gather over the mountains, a Bayamo blast may be expected; after this, the surest prognostic is the thunder, which invariably precedes the gust; it is therefore advisable to take in all sail with the greatest expedition, so soon as the first or more distant clap of thunder is heard, the wind following it almost immediately. Fortunately, however, these dreadful squalls are of short duration; but, as a repetition of them frequently occurs at intervals of half an hour or an hour, great attention is necessary, especially during the night, to prevent the ship being unprepared; as it is almost certain that, if she were overtaken by one of these squalls, whilst under sail, she would either upset or lose her masts.

These sudden tempests are attended with sheet and forked lightning, vivid in the extreme; and the flashes following each other in quick succession, have the momentary effect of illuminating every object, and leave behind them a sort of blue indescribable appearance; the sea is whitened with foam, and the rain falls in torrents, surpassing any, perhaps, witnessed in other regions; for it appears as if the clouds had opened their store of waters to deluge the earth; in fact, we cannot better describe the extreme heaviness of the shower, than by giving the sailor's observation on it, namely, that it "comes down by buckets full." The Bayamo Squall, however, although the most awful of any in the Caribbean Sea, and creating much anxiety to those exposed to its fury, is grand and sublime.*—*Lieutenant Evans*, "Revision of Geographic Terms," page 107.

(69.) On the *Coast of Guayana*, the cool season is from November to May, when the N.E. wind reaches the shore; the hot season is from June to November, when S.E. and variable winds and calms prevail. Land winds from S.W. to N.W. blow at intervals close to the shore.

On the Coast of Guayana (the *Derrotero* again continues) there are no land-breezes, nor more wind than is generally experienced between the Tropics. In January, February, and March, the winds here blow from North to E.N.E., and the weather is clear. In April, May, and June, the winds are from East to S.E. In July, August, and September, there are calms, with Tornados from South and S.W.; and in October, November, and December, there are continued rains, while the sky is, in general, obscured by clouds. In the dry season, which is from January to June, the heat is very great; and in the wet season, from August to November, rains and thunder are constant and violent.

On the Coasts of the Venezuelan provinces of *Cumana* and *Caraccas*, as far West as Cape la Vela, the Trade breeze follows by day the regular course, E.S.E. to E.N.E., but at night inclines from the land. From that cape to Cape San Blas, along the *Coast of New Granada*, the general wind alters its direction, for it blows from N.E. or N.N.E., except in the months of March, April, May, and June, when it comes to E.N.E., and is then so uncommonly strong as to render it necessary for vessels to lie-to. These gales, which are well known to mariners, extend from about mid-channel of the Caribbean Sea to within 5 or 10 miles of the coast, where they become weak, especially at night. The Trade Wind blows from the N.E. into the Gulf of Darien with great strength from November to March, or later.

In July, August, and September, vessels proceeding to windward will frequently be assisted by a Westerly wind near the coast. As far as the Gulf of Nicaragua, these Westerly winds occur from July to November or December, and are known to the pilots of that country as *Vendavales* (rainy winds), but these winds never pass the parallel of 13° N., nor do they blow constantly, but alternate with the sea-breeze.

Upon the *Mosquito Shore*, *Honduras*, and *Eastern Coast of Yucatan*, the general Trade Winds or breezes prevail from January to June; but, during the first two or three of these months, they are occasionally interrupted by *Norths*. In June, July, August, and September, the wind generally comes from the S.E., with occasional very heavy squalls from the S.W., tornados,

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* The winds on the South Coast of Cuba, when the Trade is not blowing steadily, have a remarkable rotary motion following the course of the sun, according to Dové's Law of Gyration (19). Thus, in the evening, the wind comes off the land about North; by daylight it will be N.E.; at 8 a.m., E.N.E.; at noon, E.S.E.; at 2 p.m., South; at 4 p.m., S.W., in which quarter it generally dies away into a calm until the land-wind comes off again. By a knowledge of this a vessel may creep fast to windward during the calm months of May, June, and August, and frequently at other seasons. The Trade is found to be unsteady, especially in the night.

(72.) Commander G. A. Converse, U. S. S. *Enterprise*, states that what is designated in Aspinwall (Colon) as a "Norther" is not necessarily a gale of wind. In fact, the wind frequently does not blow home, and is at such times quite light; but a very heavy ground swell heaves into the bay. When the wind does blow home, as happened during the Norther of December 19—21, 1890, no vessel can remain at anchor with safety.

There is no way of predicting these dangerous Northers. The barometer gives no indication; the "fitful showers of rain in large drops" may or may not be an indication. The gradually increasing swell supposed to be a forerunner of a Norther frequently proves to mean nothing. The Norther of December 19—21, 1890, was preceded, on the 18th, by a heavy swell and threatening weather, but towards evening the swell decreased, the weather cleared, and it looked like a fine night. Later in the night the swell commenced to heave in with greater force, so that steamers were compelled to leave their wharves. After daylight on the 19th, the full force of the Norther began to be felt, and in a very short time it became so rough that all steamers put to sea. The Pacific Mail steamer *Newport* cut her lines and steamed across the bay to the anchorage under the lee of Toro Point, but was soon compelled to abandon this anchorage and put to sea. One steamer, lying in the harbour, with two anchors down, dragged nearly 1 mile before she could get sufficient steam to be able to slip and go to sea.

During the season of Northers, steamers visiting this port keep steam up constantly, and are ready to move at a moment's notice. However long the weather may have been threatening, when the Norther does break it comes suddenly and leaves no time for preparations. If compelled to get under-way, the surest way is to slip the cable and steam out to sea. It would be almost impossible to get up anchor without damage to the ship at such times, and there is always a risk of hooking the old anchors and chains with which the bottom of the harbour is strewed.

In standing off and on the Port of Aspinwall, the *Enterprise*, having on three previous occasions encountered the Easterly current which habitually sets along the coast, made allowance for it on the 19th, the first day of the Norther, with the ship kept under steerage way only, heading N.N.W. By an observation between rain-squalls, on the morning of the 20th, it was found that the Norther had practically neutralized the current; the absence of driftwood, seaweed, and floating logs had been remarked. On the night of the 20th, the Norther had somewhat abated, and the ship was headed N.N.W., as on the preceding night. On the morning of the 21st, a certain amount of drift was observed, and, when an observation was obtained, it

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wind gradually freshening. At sunset the *cumuli* changed into dark *nimbus*, of a deep purple, edged with a bronze colour; from these clouds proceeded squalls with rain, the wind veering from N.E. to N.N.W., after which it cleared up, the clouds all dispersed, and at 8 p.m. a fresh *North* came on, with a rapidly-rising sea (which a short time before had been perfectly calm and smooth). The sympiesometer fell to 29·80, which was lower than it had ever done before. It blew a gale all night, with a heavy sea; no clouds; the stars bright and large. The same white hazy-like appearance took place before the *North* set in. Early in the morning of the 16th the wind died away suddenly, almost to a calm; and at 8 a.m. became a moderate breeze."

was found that the ship had been set to the N.E. some 16 miles in 9 hours.

While it is usually thick with frequent rain-squalls during these Northers, there are times when it lifts and the high land at the back of Point Manzanilla can always be recognized if within 30 miles of it. If it is clear, it can be distinguished much farther off (from 40 to 60 miles).—*United States Notice to Mariners, No. 9 of 1891.*

Northers are winds proceeding from an Anti-Cyclone over Northern Mexico and Texas, when there is a storm or region of low pressure moving up the Atlantic coast of the United States. The name *Norther* is applied to the heavy sea, even though the wind itself may not reach as far South as Colon. On December 18th, 1890, at Colon a heavy swell set in, with threatening weather, moderating towards the evening, but increasing at night to such an extent that all the steamers had to put to sea. In this case, observations prove that an Anti-Cyclone was moving slowly Eastward over Texas, the North-Westerly winds in its front swept down through Yucatan Channel, and, combining with the North-Easterly winds prevailing over the Caribbean Sea, sent very heavy seas from the Northward into Colon.*

(73.) The *Wet Season*, or *Season of the Breezes*, at Vera Cruz, is from March to September; the breezes at the end of March, and through the whole month of April, as already explained, are, from time to time, interrupted by Norths, and are from E.S.E., very fresh; the sky sometimes clear, at other times obscure. At times these come from S.E., and continue all night, without giving place to the land-breeze, which prevails in general every night, excepting when the North wind is on. The land-breeze is freshest when the rains have begun.

After the sun passes the zenith of Vera Cruz, and until he returns to it, that is, from the 16th of May to the 27th of July, the breezes are of the lightest description, almost calms, with much mist or haze, and slight tornados. After that time the pleasant breezes from N.W. to N.E. sometimes remain fixed.

From the 27th of July to the middle of October, when the Norths become established, the Tornados are fierce, with heavy rains, thunder and lightning; those which bring the heaviest wind are from the East, but they are also those of the shortest duration. Calms also occur.

In the season of the breezes the total variation of the barometer is 0·4; the greatest ascent of the mercury is to 30·36 inches, and its greatest descent to 29·96 inches. The thermometer in July rises to 87°, and does not fall to 82½°. In December it rises to 80½°, but never falls below 66½°. This, it must be understood, was ascertained in the shade, the instrument being placed in one of the coolest and best ventilated halls in the castle.

In the months of August and September, rarely a year passes without Hurricanes near Florida and the Northern Antillas; but to Vera Cruz, or any part of the coast thence to Campeché, they seldom or never arrive; all that is felt being the heavy sea, which has arisen in the higher latitudes. Hurricanes begin to the Eastward and Northward; and, although they do not always go round the same way, yet, in general, they next go to the Southward and Eastward, with thick squally weather and rain.

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* United States North Atlantic Pilot Chart, March, 1891.

From *Tampico* to the *Bay of San Bernardo*, breezes from the South-Eastward are steady and pleasant from April to August; but, in the remaining months, this coast is much exposed to gales from the East and E.S.E., which blow without intermission for two or three days, before a North comes on. As far North as about latitude 26½°, there are land-breezes in the summer, which blow from midnight until 9 a.m.

(74.) **Gulf of Mexico, North Coast.**—On the *Louisiana Coast*, from San Bernardo Bay to the Mississippi, in winter, the South winds are very tempestuous and squally, the most dangerous months, however, being August, September, October, and November, the season of Hurricanes. Between the Mississippi and lat. 28° N., on the *Florida Coast*, from April to July, the Trade Wind prevails from N.E. and S.E. in the morning, changing in the evening to S.W. These S.W. winds, known as *Virazones*, are very squally in August, September, and October, during which months South winds blow hard. North winds blow from November to March.

On the *West Coast of Florida* the Trade Wind blows till noon in summer, when the sea-breeze sets in. In winter, November to March, the wind blows from S.W., and raises a heavy sea.

In *Florida Strait*, and over the *Bahama Islands*, the Trade Wind blows from one or two points Northward of East in winter, and to Southward of it in summer. Northers occur in the former season. From June to October, at the Bahama Islands, light Southerly winds and calms, with terrific squalls, are experienced.

A series of observations on the Winds and Tides were made by the officers of the United States Coast Survey, between June, 1847, and July, 1852. The force and direction of the wind were noted at three stations—at Galveston, in Texas, lat. 29° 18′ N., long. 94° 46′ W.; at Fort Morgan, Mobile Bay, about the middle of the North coast, in lat. 30° 13′ N., long. 81° 0′ W.; and at Kay West, one of the Florida Kays, in lat. 24° 38′ N., long. 84° 48′ W. These observations, however, have the same imperfection as that noticed in the note (*) on page 133—that the winds are not recorded equally for all points of the compass. However, the following general remarks are useful and interesting as derived from these observations, and are arranged in the form of diagrams, which need not be repeated here.

(*a*). Winds from some Northern quarter prevail from September until February, both inclusive, and Southerly winds from March to August, inclusive. Winds from the Eastward prevail throughout the year, except at Fort Morgan, in May, June, July, and August, when the sea-breeze is from the S.W. In the whole year the winds from the same quarter, North and South, balance each other nearly, while the Easterly wind greatly predominates over the Westerly.

(*b*). The months may be arranged, according to the prevailing winds, into the following classes:—The Winter, consisting of December and January; the Spring, of March and April; the Summer, of May, June, and July; of preparation for change, August; the Autumn, of September, October, and November.

The Winter and Summer types are extremely distinct. At Kay West, in December and January, N.E. and North are the prevailing winds; at Fort Morgan, North, E.S.E., and East; at Galveston, North and N.W.; then E.N.E. and S.E. The general course of the N.E. Trade Wind is supposed to be disturbed by local action at Fort Morgan and Galveston, the local position of greatest warmth being the Gulf.

The Summer type, May, June, and July, gives S.E. as the prevailing wind at Kay West; winds from the S.E., South, and S.W. (sea-breeze), at Fort Morgan; and from South, S.E., and East, at Galveston, blowing towards the land.

August resembles July, with the appearance of winds which prevail in the autumn.

In September, October, and November, at Kay West, winds from E.N.E. prevail; at Fort Morgan, North, N.E., and East; and at Galveston, North, N.E., East, and N.W.

In March and April, the spring period, S.E., S.S.E., and East winds prevail at Kay West; North, S.S.E., and E.S.E., at Fort Morgan; and North, S.E., and South, at Galveston.

February resembles January, with a preparation for the spring period; and, like August, it is characterized at Fort Morgan and Galveston by a general diminution in the quantity of wind.

January presents the full winter type of the winds on the Gulf; and June and July the full summer type. The changes are quite gradual, and tolerably regular, from one extreme to the other.

(*c*). The following deductions are made from these observations in regard to the least and greatest quantities of wind in the principal directions in different portions of the year.

The North wind is at a minimum at the three places in July, and at a maximum in January; it is a very remarkable feature at all three places in January. The N.W. wind almost dies out at all three from May to September, first gaining strength at Galveston, in October, and reaching its maximum in all the places in December. Its quantity at Kay West and Fort Morgan is small when at the maximum.

The Northers and North-Westers both appear in force in April, at Galveston. There is very little West wind at either place, but more at Fort Morgan than either of the others, and chiefly during June and July.

South-West wind is of rare occurrence, except at Fort Morgan, where it constitutes the sea-breeze of summer, and reaches its maximum in June and July, suddenly diminishing in September.

There is but little South wind at Kay West; at Fort Morgan it increases in amount in the spring, and is the greatest in June. It is decidedly a marked feature as one of the prevailing spring winds at Galveston, reaching its maximum in May, and becoming quite small in August, re-appearing in the winter, and rapidly increasing in March.

The N.E. wind is at a minimum at the three places in July and August; is largest in quantity in September, October, November, and December, at Kay West; in September and October, at Fort Morgan; and in September, December, and January, at Galveston. The sudden increase of this wind in September, after its small quantity in August, is remarkable at all three places.

The winds intermediate between N.E. and S.E. occur during the changes from N.E. to S.E., and it would be of little value to refer to the greatest and least quantities.

The S.E. wind is at a minimum in December and January at Kay West; in January and February at Fort Morgan; in December and January at Galveston. It is at a maximum at Kay West in July; but, being replaced during the summer to a great extent by the sea-breeze (S.W.) at Fort Morgan, makes its minimum in November, and at Galveston in May, doubtless from the disturbing effect of the land; it is again large in July. This is the sea-breeze of Kay West, and, as well as the South wind, that of Galveston.

(*d*). The movement of the prevailing wind at Kay West, where the disturbing causes of the land are the least, is very instructive.

The prevailing wind in April, May, June, and July, is the S.E., hauling to the Eastward in August, and becoming E.S.E. In September and October it passes farther North to E.N.E., and in November and December becomes N.E.; in January it reaches North; returning Southward, in February it is N.N.E., in March East, and reaches the S.E. in April. The local action is thus seen to prevail for the greater part of the year over the general. For the whole year the S.E. wind exceeds any other from an Easterly point.

The Easterly wind at Fort Morgan reaches no farther South than E.S.E. in the spring and summer. In September, the prevailing wind is N.E., passing to E.N.E. in October, and back to E.S.E. in the winter and spring. The general tendency for the year is then E.S.E.

The changes at Galveston resemble those at Kay West, the general absence of E.N.E. and E.S.E. winds being due to defects in the observations.

In the *Strait of Florida* the Trade breezes are the prevailing winds, but they are interrupted by Norths in the winter, and by Calms in the summer. Although the Northern limit of this channel is within the boundary of the Trade Wind, it is necessary to remember that in winter, or from November till April, the variable winds from the Southward and Eastward, and Southward and Westward, are met with in lat. 27°, and even before; and in summer, from May until September, the winds in the whole channel are variable from the Southward and Eastward, and Southward and Westward.

5.—EQUATORIAL CALMS AND WINDS.

(75.) The N.E. and S.E. Trades, blowing towards each other, meet and are neutralized near the Equator (6). This neutral line of Calms and Varying Winds is sometimes known by the name of the "Doldrums," an uncouth term, which, we think, has had unmerited authority given to it. It is, perhaps, a corruption of the Spanish *doloroso*, or old Portuguese *dolorio*, "tormenting."

Commander Maury says, "This region of Doldrums has a mean average breadth (around the globe) of about 6 degrees of latitude. In this region, the air which is brought to the Equator by the N.E. and S.E. Trades ascends. This Belt of Calms always separates these two Trade Wind zones, and travels up and down with them. If we liken this Belt of Equatorial Calms to an immense atmospherical trough, extending as it does entirely around the earth; and if we liken the N.E. and S.E. Trade Winds to two streams discharging themselves into it, we shall see that we have two currents perpetually running in at the bottom, and that, therefore, we must have as much air as the two currents bring in at the bottom to flow out of the top. What flows out of the top is carried back North and South by the upper currents (8), which are thus proved to exist and to flow counter to the Trade Winds."

This Belt of Calms follows the sun in his annual course, though the limits do not range so much in latitude as the sun does in declination; and, generally, they pass from one extreme of latitude to another in about three months. The whole system of Wind and Calm Belts moves Northward from the latter part of May till some time in August; it then remains almost stationary till the approach of winter, when it commences to go Southward, and proceeds in that direction from December to February or March.

"The great '*sun swing*' of this Calm Belt," says Captain Maury, "is annual in its occurrence; it marks the seasons, and divides the year into wet and dry for all those places that are within the arc of its majestic sweep. But there are other subordinate and minor influences which are continually taking place in the atmosphere, and which are also calculated to alter the place of this Calm Belt, and to produce changes in the thermal status of the air which the Trade Winds move. These are unusually severe winters or hot summers; remarkable spells of weather, such as long continuous rains or droughts, over areas of considerable extent. Either within or near the Trade Wind belts it is tremblingly alive to all such influences, and they keep it in continual agitation; accordingly we find that such is its state, that, within certain boundaries, it is continually changing place and limits. This fact is abundantly proved by the speed of ships, whose log-books show that it is by no means a rare occurrence for one vessel, after she has been dallying in the Doldrums for days, in the vain effort to cross that Calm Belt, to see another coming up to her 'hand over fist,' with fair winds, and crossing the belt after a delay in it of only a few hours instead of days."*

(76.) These remarks of Captain Maury, coupled with the experience of most sailors who cross the Line, will demonstrate that the limits of this Calm Belt cannot be very exactly defined, and it is only the doctrine of chances that can determine when any particular ship will lose the Trades, and encounter the Doldrums.

On page 132 (54), is given the Table drawn up by Captain Horsburgh, as the probable Equinoctial Limits of the N.E. and S.E. Trades, and consequently of the intervening Belt of Calms. This applies to that part of them, between 18° and 26° W., which was usually traversed by the East India Company's ships. The diagram of the Winds, and also the charts illustrating Captain Toynbee's monthly discussion of the winds between 10° S. and 20° N., and from 10° to 40° W. (62), pp. 136—140, will serve to assist the seaman in quickly finding the latitude in which he may expect to fall in with these troublesome winds. In the Chapter on Passages, the routes recommended for Crossing the Equator will be found. The following approximate estimate of the breadth of this Calm Belt is derived from Maury's Trade Wind Chart, &c., and given in the Hydrographic Office Pilot Charts, and also by Dr. Van Galen.* It is of course in a measure superseded by the work of Captain Toynbee, mentioned above, but is given here, as it may be useful taken in connection with that work, in showing the amount of reliance which may be placed on these deductions:—

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* "Physical Geography of the Sea," 1860, page 358.

TABLE *of the Average Extent of the Equinoctial Calms.*

Month.	Limits.	50° to 45° W.	45° to 40° W.	40° to 35° W.	35° to 30° W.	30° to 25° W.	25° to 20° W.	20° to 15° W.
January ……	N.	3° N.	3° N.	2° N.	2° N.	3° N.	3° N.	6° N.
	S.	—	3	2	2	0	1	1
February …	N.	3	3	2	1	3	4	6
	S.	—	3	2	1	1 S.	0	0
March………	N.	8	2	0	1	2 N.	4	5
	S.	—	2	0	0	2 S.	1 S.	0
April ………	N.	8	2	1 S.	1	2 N.	3 N.	6
	S.	—	2	0	0	2 S.	1 S.	0
May…………	N.	4	4	3 N.	3	4 N.	5 N.	6
	S.	—	4	1	1	1 S.	0	1
June ………	N.	6	6	6	8	9 N.	8	9
	S.	—	4	1	2	0	1	1
July…………	N.	8	9	9	11	11	12	—
	S.	—	5	3	4	2	2	1
August ……	N.	11	12	12	12	12	13	—
	S.	8	6	4	4	2	2	1
September …	N.	11	12	12	10	12	12	—
	S.	8	6	5	4	2	1	1
October ……	N.	10	10	10	10	10	11	—
	S.	7	6	5	4	2	1	1
November …	N.	6	6	6	6	6	8	10
	S.	6	6	5	3	2	1	1
December …	N.	2	4	4	8	4	5	7
	S.	—	4	4	3	1	2	1

This Table will show that, during the winter months, and in the Western part of the ocean, the limits of the Trade Winds (as given in the Table) approximate, and leave no interval of Calm. In the Northern summer months, however, the Calm Belt is much more distinctly marked, although its mean breadth is not one-third or one-half what it is on the Eastern side. This fact is also graphically explained by the diagram of the Winds. As we said before, on pp. 131-2 (53, 54), the limits of the Trades vary to the extent of 10° of latitude, and therefore the figures given in the preceding Table can only be taken as a possible approximation.

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* "Zeil, Wind, en Stroomkaarten Toegelicht," door Dr. P. van Galen. Rotterdam.

There is one remark which it may be as well to urge here: that, as this Belt of Calms runs East and West, the navigator will clear them soonest by making a direct *Southern* or *Northern* course, as far as possible, as he thus runs directly across them; by beating too much East or West, he is retarding himself in that direction.

(77.) In modern navigation, a calm is almost more to be dreaded than a storm; for, in the former, a sailing ship is helpless, and in the latter her great sailing powers, and the many appliances now available, suffice to disarm the fury of many ordinary gales. It is, therefore, of primary importance that the commander of a sailing vessel should be aware of what regions are subject to calms in different seasons, and by this knowledge carefully avoid their detaining and troublesome influences. It is to this knowledge that the improvement of the trans-equatorial passage must be looked for. It has been strongly advocated, of late years, that a much more Westerly crossing should be taken than was adopted in former years; but it very frequently happens that the accounts of the voyages in one month abound with bitter complaints against this Western crossing, while those of another season are equally full of its praises. This topic will be more fully dilated on hereafter, in the Chapter devoted to general sailing directions. It will suffice here to give a general insight into the areas of calms and baffling winds which exist in this Equatorial belt, and especially in that part of it where the S.W. African Monsoon is felt; and in that part of our subject some further remarks will be found.

(78.) In Section 2 and its accompanying diagrams (page 108) reference has already been made to the barometric indications in these regions. In an excellent discourse given by Captain Toynbee, at the United Service Institution, May 19th, 1871, the following passage occurred, which will be in place here:—

"The ship from England, bound across the Equator, finds the wind to draw more Northerly as she approaches the Southern verge of the N.E. Trades; whilst, after passing through the Equatorial Calms, the S.E. Trades commence at South. It is also found that as this zone of Doldrums is approached, the barometer falls; it is an area of low pressure; and the zone of Equatorial Doldrums travels with it between the Equator and 10° or 12° N. during the year.

"Into this zone the air seems to blow from North to South, whilst the pressure still remains lower than on either side; we have, therefore, reason to suppose that here, on the border line of two Hemispheres, the air is drawn directly towards the lowest pressure. It will be remembered that, at a certain distance from the Equator in the Northern Hemisphere, the air draws round an area of low pressure, keeping the lowest pressure to its left, whilst at a certain distance from the Equator in the Southern Hemisphere, this order is reversed, and the lowest pressure is to the right of a person standing with his back to the wind. Hence it is reasonable to expect that the air will move directly for the area of lowest pressure in a part where the two Hemispheres meet."

(79.) The Trade Winds are essentially *evaporating* winds. From their high temperature, in passing over a large extent of ocean, they become loaded with aqueous vapour, which becomes evident when they meet and neutralize each other in this zone of Equatorial Calms.

The result is the formation of the "*Cloud Ring*" of Captain Maury, which he likens to the rings of Saturn or the belts of Jupiter. Under this oppressive and constant companion of the Equatorial Calm, the rain falls in torrents, and by the progress of the sun in the ecliptic it causes the phenomena of the tropical seasons, divided, as is well known, into the wet and dry. A consideration of the chart and the shifting of this belt will explain how it is that some places have two rainy seasons and others only one, by the passing of the cloud ring over them.

"It is broader than the Belt of Calms out of which it arises. As the air with its vapours rises up in this calm belt and ascends, these vapours are condensed into clouds, and this condensation is followed by a turgid intumescence, which causes the clouds to overflow the calm belt as it veers both to the North and South. The air, flowing off in the same direction, assumes the character of winds which form the upper currents counter (8) to the Trade Winds. These currents carry the clouds still farther to the North and South, and thus make the cloud ring broader. At least, we infer such to be the case, for the rains are found to extend out on to the Trade Winds, and often to a considerable distance North and South of the calm belt."

This oppressive region, most tedious to navigators, is, however, not at all times subject to this great amount of deposition, which has procured for it the appellation of "*The Rains*;" and especially during the winter months, when its extent is more limited, it may be crossed without encountering either those torrents of rain, or almost unbearable calms. This compensating belt to the evaporation of the Trades, of course, is subject to squalls, and especially to thunder-storms, the natural result of the conflicting elements. Altogether, its effect on the health and spirits, its enervating influences, its oppressive and damp heat, make it one of the most unpleasant regions of the globe.*

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* Attention to personal cleanliness is very important during the detention caused by these calms. Dampier gives a quaint description of the ill effects of his men not drying their clothes and lying down on their hammocks while wet, which caused all to become offensive and open to attacks of disease. Captain Maury says, "The emigrant ships from Europe to Australia have to cross it. They are often baffled in it for two or three weeks; then the children and passengers who are delicate in health suffer most. It is a frightful graveyard on the wayside to that golden land."

6.—THE AFRICAN MONSOONS.

(80.) The influence of the land upon the Trade Winds, and the intervening Calms, is very powerful on the Eastern side of the Atlantic; and the peculiar configuration of the Coast of Guinea, trending as it does along the very axis or line of division of the Northern and Southern Wind systems, causes a different set of phenomena to arise. During that part of the year when the sun is in the Southern Hemisphere, the Trades and Calms follow the normal or usual course, as it is then exerting its maximum force on the sea with its low absorptive and radiative powers; but when, during the Northern summer, it is raising the temperature of the land of the Guinea Coast, a new phase arises from the heated atmosphere over the land drawing the wind towards it; and instead of a S.E. or N.E. wind, we have a South and S.W. wind occurring with great regularity. Major Rennell says, "In the space lengthwise, between Cape Verde and Cape Mesurado, and in certain places to the extent of 200 miles off shore (150 off Sierra Leone), a regular change of winds and currents takes place, according to the seasons. That is to say, a N.E. or North wind and S.E. current, from September to June; and, in the rest of the year, a S.W. wind and N.E. or Northerly currents, in effect a *Monsoon*, and this extends, in respect of the *wind*, nearly through the whole space between the two continents.*

(81.) In Dampier's Discourse on the Trade Winds, and his illustrative Chart (1697), we find a solution of the origin of these S.W. winds, which is that still held to be most feasible. It is, that they are derived from the S.E. Trades, and not from a diversion of the N.E. Trades. This also was suggested in the "Mercantile Marine Magazine," of 1856, the data being derived from Maury's charts. An important element in determining the reality or otherwise of this suggestion is the position of the Calms. Are they interposed between the N.E. Trade and Monsoon, or between the Monsoon and S.E. Trade? But this consideration may not have great weight in this region of calms, and besides the probability of this origin is increased by the data for the direction of the S.E. Trade, which is shown not to blow with regularity to the East of a line joining Cape Palmas and Angola.

(82.) There is another conclusive evidence of the Westerly extension of the Monsoons in the *Easterly* current which is met with almost constantly during the seasons of their prevalence. These are very persistent as far as longitude 40° W., and are at times encountered as far North as latitude 16°, but more usually between lats. 6° and 11° N. This origin of the anomalous Guinea Current was indicated in our chart of the Atlantic Ocean, published in 1858. A similar current is shown to exist in the Pacific Ocean, West of Panama Bay. This feature will be further dilated on when we come to the Section on Currents.

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* The existence and character of this S.W. African Monsoon was thus early recognized and named (at the latter end of the eighteenth century). The term "*newly-discovered*" Monsoons, given to them by our American friends, is therefore not quite applicable.

(83.) These South, S.S.W., and S.W. winds prevail, according to Maury's Pilot Charts, chiefly during the months of July, August, September, and October, and are then felt as far to the Westward as 35° or 40° W., between the parallels of 5° and 8° N. In the Western part of this area they diminish in frequency as the sun proceeds to the South, and are scarcely felt in the North Atlantic during the months of December, January, and February. The chances of encountering this adverse wind must have an important bearing on the choice of a route for crossing the Equator during these months, but we leave this subject to be discussed under the heading of Crossing the Equator, in the chapter on Passages given hereafter. Between December and April, which is the season most visited by calms, the wind has still a Southern tendency; but, during the season of the Monsoon, the calms are at a minimum near the coast. It is difficult to explain in words the relative duration, force, or frequency of the winds in this changeable locality, without an appeal to the chart. The reader is referred to those illustrating the Winds of the region between 20° N. and 10° S., and to the chart of the North Atlantic Ocean, in four sheets, before alluded to (48).

(84.) In the Gulf of Guinea, as far North as Cape Palmas, the prevailing winds are S.W. and Southerly; between Cape Palmas and Cape Roxo, S.W. winds prevail between June and September, and N.E. winds during the remainder of the year. In the latitude of Sierra Leone, this S.W. wind extends to long. 32° W. in the middle of the Northern summer.

(85.) The following remarks, by the late Captain Midgley, who had great experience on the African Coast, will be found of service in explaining the character of the winds and seasons:—

I will here offer a few remarks on the general variable winds and weather which prevail between the parallels of 4° and 10° N., and the meridians of 18° and 25° W., or between the N.E. and S.E. Trade Winds.

The winds generally incline from the Southward, between the Trades, and few vessels pass from one Trade Wind to the other without meeting with very unpleasant weather, in the shape of calms, light baffling winds, squalls, and rain, particularly when the sun is much to the Northward.

In June, July, and August, heavy squalls seem to prevail from the S.W., with a great deal of rain, and the wind often blows hard from this quarter for several hours together, and then falls calm, leaving a heavy and confused short sea, which causes a vessel to labour and strain more than she would do in a gale of wind.

When the sun is far to the Southward, the weather is comparatively fine, with light Southerly and S.E. winds, occasionally, however, interrupted by squalls and rain; and the calms are of shorter duration, owing, probably, to the limited breadth of the space between the Trade Winds at this season.

In this part of the ocean, when much lightning is seen in a heavy dense cloud, in any quarter of the compass, the wind may be expected to come out suddenly from that quarter, especially if there is any rain, even though the wind may be blowing at the same time with moderate force from an opposite quarter. Forked or chain lightning is the almost sure forerunner of a heavy squall; it is a monitor whose warning should not be neglected.*

Whenever there is much lightning, and the wind is unsteady and baffling about, prepare for a change. A heavy dense cloud, having a squally appearance, may rise and pass slowly over the vessel directly to leeward, with perhaps little or no increase of wind; and when the danger may be supposed over, the vessel is suddenly taken aback with a smart squall. This, I presume, arises from the cloud which has just gone over the ship, being opposed in its progress to leeward by a stronger current of air from the opposite quarter. On this account, when clouds are in motion from opposite quarters of the compass, a better look-out, if possible, should be kept to leeward than to windward.

Keeping a good look-out upon the surface of the water is an excellent method of judging of the force of the wind in an approaching squall; but, on account of the heavy rain which invariably accompanies the squalls alluded to, very little sound judgment can be exercised with respect to their strength; they are generally, however, tolerably heavy, and require sail to be considerably reduced.

In June, July, and August, the weather is very wet and squally. Sometimes dense masses of clouds are seen in rapid motion from the S.E., Southern, and S.W. quarters of the horizon: these clouds have a bulky and confused appearance, as if tumbling or rolling over each other; are of a dirty dark drab colour, with ragged edges, and inky-looking small clouds flying about the edges of them. In their approach towards the zenith they gradually appear to unite and form the apex of an angle, and, thus united, blow with incredible violence from the S.W. quarter (veering about two or three points or more) for upwards of two hours, during which time the rain descends in torrents, perhaps accompanied by a waterspout or whirlwind.

Ships should be well prepared for these dangerous visitors; for they come with a similar violence to the Arched White Squall of the West Indies. I have experienced two squalls of the above description (both in the month of July), and in one of them lost a good fore-topsail, after the reef tackles, &c., were hauled out snug, and the ship had been for some time running directly before the wind. Upon both occasions my barometer fell three-tenths of an inch very suddenly, which enabled me to take in sail in time; for the squalls did not look particularly alarming until about eight or ten minutes before they reached the ship.

To the inexperienced in this part of the ocean, I would beg to remark, that *much* sheet lightning is always suspicious, and forked or chain lightning universally so; and the latter is, in some degree, indicative of a change, as of an increase of wind.

After the wind has blown steadily, with fine weather for a few hours, and it then begins to be variable, and fly suddenly about, squalls and rain may be expected.

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* In those parts of the North Atlantic Ocean which are not in the general influence of the Trades, I have very frequently remarked that lightning is indicative of a change of wind.

The moon has great influence on the weather; for it is most squally and unsettled, with much rain, about the full and change.

I perfectly agree with Captain Cheveley, that the month of July is, perhaps, the worst in the year for making southing between the Trades. I have made two homeward passages in July between the meridians of 22° and 26° W., and met upon each occasion with the same weather as described by that gentleman; namely, strong S.W. winds, hard squalls, and torrents of rain, with a heavy sea, and Northerly currents.

(86.) *Between Cape Blanco and the entrance of the River Gambia*, Captain J. W. Monteath states that during the months of November, December, January, February, and March, the winds from the East and N.E. are prevalent. In this time the nights are cool; but scarcely has the sun arisen above the horizon, when the air becomes dry and parching. Nevertheless, these five months are the winter in this part of Africa, and this is the most healthy season. Between the Gambia and Cape Palmas the inland winds, during the same season, are variable.

In June, July, August, September, and October, the country situated between Cape Verga and Cape Mount is much exposed to Hurricanes or Tornados. These, however, do not occur in any part of the coast Northward of Cape Verga. From the 20th degree of North latitude to the environs of the Line, the atmosphere emits its waters to the earth; the only difference is, twenty days sooner or later in the arrival of these torrents. During the other eight months in the year there does not fall a single drop of water.

Between the *Cape Verde Islands*, and in their neighbourhood, Southerly and S.W. winds generally blow in July, August, September, and October. These islands, when the sun is in their zenith, are generally surrounded by thick fogs.

From *Sierra Leone to Cape Palmas*, the ordinary course of the winds on the coast is from W.N.W., and beyond Cape Palmas, from W.S.W. to S.W. and S.S.W.

Although, in the Gulf of Guinea, the wind blows generally from the Southward, and S.S.W. toward the coast, they take, in South latitude, a more Westerly direction near the land, and then prevail from S.W. and W.S.W. between Cape Lopez and Benguela. But they veer proportionally more Southerly as the distance increases from the coast.

WINDWARD COAST, &c.—The name of *Windward Coast* has been given by our navigators to the whole of that coast which extends from Cape Mount to the River Assinee, thus embracing the Gold Coast, and thence continues to the Westward, including the three particular coasts called, 1st. The Coast of Adou, or Quaqua; 2nd. The Ivory or Teeth Coast; 3rd. The Grain or Pepper Coast.

From January until May, the weather here, along shore, is commonly fair and clear, with cooling breezes, and gentle Southerly winds. But about the middle of May, South and S.E. winds begin, accompanied not only with Hurricanes and stormy gusts, but also with thunder, lightning, and great rains, which continue, more or less, until the conclusion of the year.

On the Gold Coast, from Assinee to the River Volta, the wind in January begins to blow from the S.W. quarter, and becomes stronger in February, bringing with it sometimes rain, and sometimes a Hurricane. About the end of March, and beginning of April, those heavy tempests, called by the Portuguese *Tornados*, arise, accompanied with a deluge of rain, thunder, and lightning; these continue to the end of May, and are announced by the darkness of the sky in the S.E.

During the rainy season, that is, in May and July, little or no land-winds are felt; but from the sea it blows from the S.W. and W.S.W., making a very great swell, which continues even in August, although the rains begin to cease in that month.

The weather becomes fair in September, and the air clear, with gentle South winds; and this continues till January, the hottest days being in December.

(87.) Commander E. G. Bourke, R.N., F.M.S., remarks: The winds on the African coasts are already so well known as to render much comment unnecessary, the usual sea and land-breezes being, with few exceptions, constant; the latter, however, are nowhere very strong, and as a rule are not felt before midnight, nor do they last later than 8 a.m. The sea-breeze commences about 10 a.m., reaches its maximum strength at 4 p.m., and then gradually falls light, but frequently, and especially in the Gulf of Guinea, it maintains its full strength until it suddenly drops, and gives place to the land-breeze. The sea-breeze blows from West to N.W. to the North of Cape Palmas, to the South of that point it is from S.S.W. to W.S.W. true. North of Cape Palmas the land-breeze comes from East to E.N.E., from Cape Palmas to Fernando Po from the N.W., thence to Cape Lopez (1° S.) from the East, and to the South of that cape it is from the S.E. These breezes extend nowhere far from the shore, as at a distance of 20 miles to seaward the constant S.W. Monsoon is but rarely disturbed, and then only by Tornados and the Harmattan.

The chief characteristic of the climate of the Coast of Western Africa is moisture, which is accompanied by a temperature by no means high for the latitude. This averages 79° between the Equator and 10° N.; from the Equator to 10° S. it is from 4° to 5° lower.—*Journal of the Meteorological Society*, Vol. iv., 1878, pp. 25, 27.

(88.) *Remarks by Baron Roussin.—Cape Bojador to the Isles de Los.*—On the whole extent of the African coast there are but two seasons, namely, the *rainy and dry seasons*. The division of the two is connected with the periods when the sun crosses from one Hemisphere to the other, and is modified as he advances to, or recedes from, the Equator.

The *Rainy Season* commences at each place on the coast to the Northward of the Equator, at the time when the sun passes the zenith of that place in his course to the Northward. It is, usually, during the month preceding this event that the change of weather takes place. It may therefore be calculated that, at the Isles de Los, the first point exposed to the rainy season, and which lie in 9½° N., the first violent squalls do not occur before the 10th or 15th of May. Their arrival seems to be affected by the moon; for they almost always commence, and are most violent, on the days of the new and full.

The rainy season* ends in very violent squalls, with intervals of calm, of which there are at least two, and frequently more, during the twenty-four hours; and we remarked that they generally happen on the rising or setting of the sun or moon. In the country, these squalls are generally called *Tornados;* but, according to the best information, the Tornado, properly speaking, is to be met with only to the Southward of Cape Verga. They generally begin to form themselves in the N.E. or E.N.E. quarter of the horizon, which seems completely on fire during an hour or more. The storm then gradually shifts round to East and E.S.E., becoming darker in the horizon. Having arrived at S.E., it attains its full vigour, when thunder and lightning become incessant. A moment of absolute calm then takes place, which is caused by the obstruction which the usual winds from the N.W. meet with from this immense mass of clouds. Shortly after, a small arch is formed at the horizon, which increases and rises rapidly. The more defined the edge of this arch appears, the more violent will be the storm, as it is a proof that the column of air has divided much heavier clouds, and is more confined. When the summit of this arch has attained an altitude of about 45°, the hurricane bursts forth, and torrents of rain immediately follow. The crisis of its greatest violence generally lasts from 15 to 20 minutes; it afterwards gradually becomes weaker; and, finally, nothing remains but rain, attended with very little wind. It then shifts round from S.E. to W.S.W., then to the quarter from which the usual winds blow, to exhaust itself to the Northward in another squall from the S.E.

The *rainy season,* at any place, continues from four to six months, according to its proximity to the Equator, and the Tornados continue to decrease, both in frequency and violence, during the two latter months of the season. In ten days or a fortnight after the sun has passed the zenith of any place on his way to the South, it is considered as free from bad weather. On the 15th of November, a gun is fired at Goree, which announces the return of the fine season.

The squalls here spoken of, and the winds which precede or follow them, generally occupying so very small a portion of the year, may be considered as momentary convulsions in a state of climate almost unchangeable; a sky nearly always serene, and generally clear.

On the greater part of the African coast, from Cape Bojador to the Isles de Los, regular winds blow, and no rain ever falls during eight months. The prevailing winds in this country blow from N.E. to N.W.; it may, therefore, be said that they follow the direction of the coast from North to South, and that they seldom vary from the limits here assigned.

The *dry season* commences in the latter part of October at Senegal; a little later at Goree; and at each intermediate place toward the Equator it becomes gradually later. It is not till the beginning of December that its return is observed in the parallel of the Isles de Los.

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* Captain Adams, in his sketches, says that the Wet Season, North of the Equator, commences in the month of May, and terminates in July, when the Dry Season begins, although heavy showers of rain fall during the months of October and November, which enable the Africans to reap a second harvest of maize; but the rains commence and terminate six weeks earlier near the Equator than at the Northern boundary, where the periodical rains cease.

(89.) Lieutenant Bold also says, that the Winds and Weather on all parts of the Windward Coast are much alike, excepting that the rains commence rather earlier in the S.E. The wintry season makes its appearance early in June, by strong breezes and occasional heavy gusts from the Southward and S.E., accompanied with rains, which increase violently and continue until the latter end of August; this is succeeded by a series of close foggy weather, during which the land appears enveloped in vapour, occasioned by exhalations from the humid soil. This is justly considered to be the most pernicious season in the year to the European constitution; the whole atmosphere being then impregnated with deleterious matter, generated by decayed vegetation. During the rains there are no land winds, neither in the month of October, when the wind is strong down the coast; in the following month it gradually draws down to the South and Westward, with occasional rain. Toward the middle of December the weather begins to clear up, and the summer season to make its appearance; this continues until June, with a beautiful clear sky and gentle refreshing breezes from the S.S.W., during the last ten or twelve weeks of which the Tornados prevail very violently; but these come on generally in the evening, and give ample warning to the navigator to prepare against their dreadful impetuosity.

The same intelligent navigator adds:—The seasons on the *Gold Coast* are precisely similar to those of the Windward Coast, with the exception of their successively commencing a month earlier. Along the coast, in the winter season, when the winds are from the S.W. the swell and surf on the beach are excessively high, and too dangerous in many parts to permit landing.

The seasons on the Coast of Dahomey, &c., are nearly similar to those of the Gold Coast; the rains commencing in May, preceded by Tornados and equally boisterous weather, with Southerly and S.S.E. winds from the month of March, causing a heavy sea in the bight, with a violent surf along shore. The finest months here are from September to March, during which the winds are from W.N.W. to W.S.W., with cool refreshing breezes by day, and land winds at night. But it is to be observed that, in the rough season and the winter months, there are no land winds, and the current is frequently found running rapidly to windward.

(90.) Commander E. G. Bourke remarks, that on the coast of *Liberia*, between *Capes Mount* and *Mesurado*, as well as upon the coast Westward, between Cape Mount and *Cape St. Anne*, the rains begin with May, and continue till October, accompanied with great thunder and lightning, and furious gusts of wind from the North-Westward. During this time the sea sets so hard to the N.E. along the coast, and with mountainous billows, that it is impossible to approach the shore; so that sailing ships which, between July and September, happen to fall below Cape Mount, cannot, without great difficulty, get about to the South.

The Winds, &c., of the Bight of Biafra, and the African Coast to the Southward, are described in the "Directory for the South Atlantic Ocean," by the author of the present work.

(91.) **The Harmattan.**—On the Gold Coast, as well as the Windward Coast, an Easterly wind, called the *Harmattan*, prevails during the months of December, January, and February. This wind comes on indiscriminately, at any hour of the day, at any time of the tide, at any period of the moon, and continues sometimes only a day or two, sometimes five or six days, and it has been known to last fifteen or sixteen days. There are generally three or four returns of it in every season; it blows with a moderate force, not quite so strong as the sea-breeze, which every day sets in, during the fair season, from the West, W.S.W., and S.W.; but somewhat stronger than the land-wind at night, from the North and N.N.W.

In the "Philosophical Transactions," vol. lxxi, 1781, an account of the *Harmattan* was first given by Matthew Dobson, M.D., F.R.S., from the enquiries and observations of Mr. Norris, of which the following is the substance:—

On that part of the Coast of Africa which lies between Cape Verde and Cape Lopez, a singular periodical Easterly wind, named, by the natives, *Harmattan*, prevails during the months of December, January, and February. Cape Lopez lies to the Southward of the Line. At the Isles de Los, which lie to the Northward of Sierra Leone, this wind blows from the E.S.E.; on the Gold Coast, from the N.E.; and at Cape Lopez and the River Gaboon, from the N.N.E.

The Harmattan comes on as above described. A fog or haze always accompanies it, and the gloom is sometimes so great as to render near objects obscure. The sun is thus concealed the greatest part of the day, and appears only a few hours about noon, and then of a mild red colour. At 2 or 3 miles from shore the fog is not so thick as on the beach; and at 12 or 15 miles distance it is entirely lost, though the Harmattan is felt for 30 or 35 miles off shore, and blows fresh enough to alter the course of the current.

Extreme dryness is a property of this wind. No dews fall during its continuance, nor is there the least appearance of moisture in the atmosphere. All vegetables are much injured, and many destroyed. The seams in the sides and decks of ships become very leaky, though the planks are 2 to 3 inches thick. Iron-bound casks require the hoops to be frequently driven tighter, and a cask of rum or brandy can scarcely be preserved; for, unless kept constantly moistened, the hoops fly off. The Harmattan has, likewise, very disagreeable effects on the skin, lips, and nose, which become sore.

The effects of the Harmattan in evaporation are great, as will appear by the following comparative statement:—At Liverpool, the annual evaporation is about 36 inches; at Whydah, 64 inches; but, under the influence of the Harmattan, at the rate of 133 inches.

This wind, though so prejudicial to vegetable life, is highly conducive to health; so that fluxes, fevers, small-pox, &c., generally disappear in spite of the doctor; and it contributes to the cure of ulcers, and cutaneous eruptions. The baneful effects which have been said to arise from the prevalence of this wind proceed from the periodical rains, which fall in March, April, &c., and are ushered in by the Tornados from the N.E. and E.N.E., accompanied with violent thunder and lightning, and very heavy showers. The earth, drenched by these showers, and acted upon by an intense solar heat so soon as the storm is over, sends forth such noisome vapours as are the occasion of putrid fevers and other diseases.

On this coast, from the middle of February to the first week in March, a wind up the coast, from S.S.W. to S.S.E., prevails for about three weeks. The Tornado season embraces part of March, all April, and the greater part of May, about twelve weeks altogether. The rainy season sets in at the latter end of May, lasts all June, and till about the 20th of July, about eight weeks. Hence, high winds and squalls, with very heavy rains, to the middle of August, about three weeks. The rain ceases; and then, for the first three weeks in September, the weather is foggy and close, without any breeze. From this time, for about six weeks, the wind blows fresh down the coast; the Tornados and Southerly winds then succeed, with some rain, generally called the *latter rains*, lasting about four weeks, to the beginning of December, when the Harmattan season commences.

(92.) *Remarks on the Harmattan, by Baron Roussin.*—Although the winds from N.E. to N.W. prevail on the N.W. Coast of Africa during the dry season, that is, from November to May, they are, nevertheless, occasionally interrupted between the 1st of December and the 1st of February by the land-wind, which blows from E.N.E. to E.S.E., and sometimes with violence.

It is this wind which the inhabitants of the country call the Harmattan. It comes on at different periods in the above interval, and blows during one, two, and sometimes five or six successive days. This continuance, however, is rare, as it is generally interrupted by the sea-breezes, which commence about noon, after a calm of one or two hours. These alternate land and sea-breezes generally last till the end of February, when the usual winds entirely prevail. The Harmattan, which passes over the most arid country of the globe, is of an extremely dry nature, and would probably become insupportable, were it not frequently allayed by the sea-breezes above mentioned. Notwithstanding the salutary effect of these breezes, the drought is astonishing, so long as the Harmattan lasts. Mankind is inconvenienced; vegetables suffer so much as to be nearly killed; the sun loses its brilliancy, and is only to be seen when near noon; the sand, brought with it from the desert, pervades the atmosphere, and prevents objects from being distinguished at the distance of a quarter of a mile. Nevertheless, the effect of the Harmattan is not really injurious to health; it is remarked that it even purifies the atmosphere, by destroying the noxious vapours with which it is replete on the conclusion of the rainy season. It is usually on the return of the Harmattan that recovery commences from disorders which are incident to the climate.

The fog which accompanies the Harmattan loses nothing of its density when 9 miles out at sea. On the edge of the Bank of Arguin, which is 30 miles from the land, it prevented our distinguishing the horizon during three successive days. This state of the atmosphere is not permanent, but varies with the winds which produce it; and, in general, independent of the Harmattan, the African Coast, from Cape Bojador to Cape Verde, is continually covered, during the whole dry season, with a white mist, which is seen from the sea much sooner than the land, of which it is a sure indication. This mist, which is nothing but sand, the extreme fineness of which allows of its being supported by the least agitated air, is particularly remarkable on that part of the desert between the parallel of 22° and Senegal. We have seen it at the distance of 15 miles, when the coast could scarcely be seen at 9 miles.

This dust, alluded to on pp. 99—100, is further remarked on at the end of this volume; by some it is considered to consist of fine ashes blown from the regions of forest fires in the interior.

(93.) *Remarks by Captain T. Boteler, of H.M.S. Hecla.*—Between the Isles de Los and Sierra Leone, the *Harmattan Season* sets in with November, or about a month earlier than off the Gambia, and prevails through December and part of January, but not quite constantly; for occasional intervals of clear weather, accompanied by the refreshing sea-breezes from the N.W., sometimes afford a respite to its oppressive effects. Nor does the Harmattan blow uniformly, either in the same direction, or with the same strength; for it ranges through eight points of the compass, from N.N.E. to E.S.E.; and, however fiery at the commencement, declines, after the first month, to a comparatively light breeze.

The *peculiar haze*, which more or less envelopes the Coast of Africa at all times, is at its maximum during the influence of the Harmattan; and, though partially dispersed by the Tornados and the rainy season, returns with increased density when they cease. Strangers should, therefore, be on their guard when estimating their distance from the land, as the deceptive effect of this haze makes it appear much farther off than it really is; for the contrast which the coast presents to the eye, in different states of the atmosphere, is very great. In clear weather, the view of the fertile shelving hills in the Isles de Los, the stupendous features of the distant mountains, the plains covered with trees, and the beautiful little island of Matacong (described hereafter), are highly interesting; while, in hazy weather, nothing is visible but a low mangrove coast, enveloped in mist, with an indistinct opening of a river here and there, or perhaps a column of smoke rising from a native village.

The *rainy season* continues for four months, from May to September; but the *Tornados*, which invariably accompany its commencement and termination, generally cease between those periods. They blow from the E.S.E., and with great fury: but they seldom last more than three hours. The prevalent winds, during the rest of the rainy season, are from the Southward and Westward, and are usually so light as to give way in the afternoon to the N.W. sea-breeze.

(94.) Mr. G. T. Carter, Administrator of the Colony of Gambia, in his Report for 1888, states that the Harmattan usually sets in early in December, and is eagerly looked for after the airless, oppressive weather in October and November. It is an exceedingly dry wind, and though cool and bracing in the early morning, becomes hot under the influence of the sun, as it slackens in the middle of the day. The Harmattan is an intermittent wind blowing for a few days, being then succeeded by the refreshing sea-breeze, which in its turn gives way to the Harmattan. This interchange usually lasts up to the middle of April, the month of February being the time when the Harmattan is most prevalent.

The months of July and October are decidedly the most unhealthy and unpleasant months in Bathurst. In July, the sea-breeze has stopped blowing, the sun is very hot, and stifling, airless days may be expected preparatory to the commencement of the rains, which are generally ushered in by the storms known as Dry Tornados, followed by these storms accompanied by heavy rain.

The middle of June is about the time when rain may be first expected, but the wet season does not become thoroughly established until a month later, the latter part of July and the whole of August and September being conspicuous for more or less continuous rain. The rainfall varies from 40 to 80 inches.

As a rule, I think it may be considered that a heavy rainy season means a healthy season, more especially if Tornados are frequent with their usual accompaniment of thunder and lightning. No one who has resided in Western Africa can fail to appreciate the pleasant sensations experienced after one of these beneficent storms has passed over; a weight seems lifted from one's being, the air becomes unusually clear and pure, and the temperature is considerably lowered. The wind seldom blows with sufficient force to do any material damage during the progress of a Tornado, and the most violent storms usually expend their force in the course of an hour or two.

The Island of St. Mary has the advantage (in one sense) of possessing a light, sandy soil, and consequently the heaviest rain soon percolates through and does not stagnate on its flat surface.

Taken as a whole, the climate of the Gambia is decidedly superior to that of any other British Settlement in West Africa, though at certain seasons intermittent and remittent fevers are very prevalent, few Europeans escaping an attack of one or other of these forms between the months of July and October. Natives form no exception to this rule, though with them the disease is rarely fatal. The point which has always struck me about the Gambia is the *dryness* of the climate as compared with Sierra Leone and the Gold Coast. From December to June there are periods of phenomenal dryness, more especially during the occurrence of the Harmattan, but the sea-breeze, which blows from the North and N.W., and is the prevailing wind during these months, is not charged with moisture to the same extent as similar winds in Sierra Leone and on the Gold Coast.

The height of the thermometer in the Gambia, or, indeed, West Africa generally, must not be taken as a guide to one's sensations of heat; for although the thermometer rarely exceeds 90° indoors, yet there are times at Bathurst when, to judge by one's feelings, 10° might well be added to the 90°. This is especially the case during the month of October, which is exceedingly trying to Europeans. The rains have ceased, and the process of drying up is going on, or, in other words, Nature's distillery for malaria is in active operation. There is rarely a breeze of any kind, or if at all a land wind charged with poison from miles of fœtid swamp. Such as it is, however, it is welcomed, for during the oppressively still days and nights there seems to be an absence of air for breathing purposes. This, however, is the dark side of the picture, and, fortunately, the state of things described is only of short duration. Taking all things into consideration, climatically speaking, the conditions of life are more bearable in the Gambia than in any other part of West Africa. This opinion, I may add, is based upon nearly 14 years experience gained in Sierra Leone, the Gold Coast, and the Gambia.

(95.) Commander E. G. Bourke, R.N., says that the haze (mentioned before) is prevalent during the whole season, so that whether the Harmattan be felt on the surface of the earth or not, it is probably going on in the upper regions of the atmosphere. By the motions of the upper clouds, the N.E. Trade seems to be always blowing over the Northern part of Western Africa, and it may be that the Harmattan is only the N.E. Trade extending itself to the surface from unusual strength, or other at present unknown cause. I observed sheet lightning every evening during the continuance of this wind, but only to seaward, which was doubtless due to the rapid evaporation from the surface of the sea owing to its being in contact with such very dry air.*

7.—WINDS AND CALMS ON THE TROPIC.

(96.) Between the N.E. Trades and the Westerly winds which prevail more or less to the Northward of them, there is a belt of variable and light winds, which have, perhaps somewhat vaguely, been called the *Calms of Cancer*—a term which will not express its characteristics.

It is called, also, the *Horse Latitudes*, from the fact that vessels in former years, employed in carrying horses to the West Indies, were frequently obliged to throw them overboard during the embarrassment caused by the continual changes, sudden gusts and calms, rains, thunder and lightning, which are general in it (42), page 124.

(97.) This zone is caused by the uniting, or interchanging, of those upper but contrary currents which pass Northwards over the N.E. Trades in consequence of the heat acquired under the tropical sun having reached the Northern extreme of this superheating influence. They here meet the currents passing Southwards to feed the Trades from the polar regions, and thus pressing against them cause the high barometer peculiar to this belt, standing as it does at a higher level than either to the North or South of it. Captain Maury infers that the mean height of the mercury in this belt is 30·21 inches, and at the Equator 29·93 inches. Admiral FitzRoy states the mean height of the barometer in the latitude of England to be 29·95 inches. This greater height of the mercury, showing increased pressure, will be an index to the sailor that he has reached this intervening belt between the Passage and Trade Winds.

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* Journal of the Meteorological Society, vol. iv., page 26.

From the lower part of this zone pass out two currents of air, one to feed the N.E. Trades, as before described, and the other to form the Anti-Trades or Passage Winds: and it is fed by the Polar and Tropical counter-currents which flow over these different wind systems.

(98.) The mean latitude of this belt is from 30° to 35° N., but varying with the motion of the sun in the ecliptic, as explained in (53), page 131. In fact, the Northern edge of the Trade Wind may be taken as the axis over which this belt moves, sometimes of great breadth, as 10°; at others, not felt at all. The mean position of these Tropical Calms, &c., will be best comprehended from the diagram of the Winds. As is well known, this belt is the line upon which the dreaded Cyclones turn; they pass to the W.N.W., to the South of it; and to the E.N.E., to the North of it; showing the origin of the struggle between the Polar and Tropical currents, which is evident in their tremendous phenomena.

(99.) As was said in (53), page 131, the range over which the Northern limits of the N.E. Trade is met with, seems to be, from Maury's chart, about 10°; but as this and later meteorological charts cannot be pronounced absolutely perfect, being derived from insufficient data, it may be said that the mean position of the Tropical Calms in the various seasons of the year cannot with certainty be predicted; but as it does not offer the same obstacles to navigation as those of the Equatorial regions, it is of less importance to the sailor, who, by ordinary sagacity and prudence, may guard against the squalls, thunder-storms, and calms, which characterize it.

(100.) To the Westward of the meridian 50° W.,—that is, the Western half of the N.E. Trade in the North Atlantic—the Trades are very light during the months of September and October; perhaps at other times of the summer and autumn. They will be most felt between the parallels of 15° and 25°; but not with any certainty near the American coast. This region may therefore be added to the Tropical Calms during these months.

As examples of the winds, as observed upon the lands lying in this belt, we select the remarks upon the Bermudas.

(101.) **Bermuda.**—The winter, or cold season, at Bermuda, is the most agreeable, and lasts from November to March, the mean temperature being 60°; the predominant winds are then from the Westward; if to the Northward of this, fine, hard weather, with a clear sky, accompanies them. This is the favourable time for refitting ship, painting, &c. The close of this is often a very fine, bright day, with little wind and partial calms, when the wind is certain of going round to the S.W.; the weather becoming hazy, damp, subject to heavy rains and gales. The thermometer immediately attains 60° to 70°. These alternate North-Westerly and South-Westerly winds prevail through nine months of the year, the wind remaining at no other point for any length of time. This change is exhibited by a difference of 14° in the temperature. At this season it seems advisable for ships bound to the southward to wait and take the first set-in of the North-Westerly winds. In most cases, it will ensure a quick run to the Variables, and often to the Trades.—*Mr. H. Davy.*

In the latter part of February, spring commences, and the weather usually continues mild, with refreshing showers of rain and gentle breezes from the

South and West, until the end of May. In June, the summer sets in, and the weather becomes hot. Calms now succeed to the gentle breezes of May; the air is sultry and oppressive, and long droughts are common, which are often broken up by heavy thunder-storms. In September, the weather changes its character, and becomes again mild and agreeable.

The dew-point in Bermuda usually ranges high. The climate being therefore moist, is favourable to vegetation at all seasons, except during the droughts of summer, and the storms of winter.

Hurricanes and tempests are very frequent, as is to be expected from the proximity of the isles to the variable limit of the Trade and other prevailing winds. Few autumns pass without Hurricanes of more or less violence.

The *Bermuda Squalls* are sudden and violent tempests, occurring particularly in the winter season. Some further remarks on this subject will be found with the description of these islands later on.

According to the observations registered at Her Majesty's Dockyard, in 1853-4, the Easterly winds, or those to the East of North or South, prevailed for a mean of 139 days, and Westerly winds for 186 days; the remainder being made up of calms and variable winds.

8.—THE ANTI-TRADES OR PASSAGE WINDS.

(102.) In a previous page, 124 (42), the reason is given for applying the term *Anti-Trades* to the variable, but Westerly, winds which prevail to the Northward of the Tropic of Cancer. In the consideration of these winds, which only extend over an area, compared to that of the Trade Winds, as 5 is to 12 (thus showing their vastly inferior importance in the atmospheric economy), it will be found that it is impossible to accurately define their direction and character at any particular season. The great difference which exists between the winds and seasons of different years, which, however, when combined with a series, show a well-marked and consistent average, will demonstrate that it is only the doctrine of chances which can determine whether a single ship will encounter a particular wind at a particular time and place. Therefore, this Section will be less definite in its teachings than that on the Trade Winds.

(103.) There is one fact which modern meteorological study has established, and that is the frequent progress of storms in an Easterly or North-Easterly direction across the Atlantic, in the regions of the Anti-

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NORTH

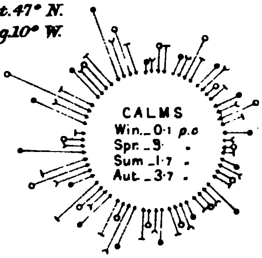
Diagrams illustrating the directions of

ANTI-TRADES OR PASSAGE WINDS.

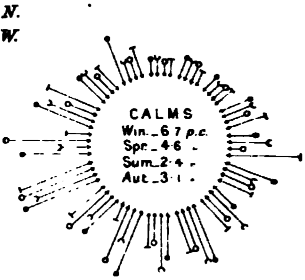
WEST

EAST

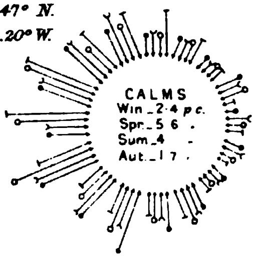
Lat. 47° N.
Long. 10° W.



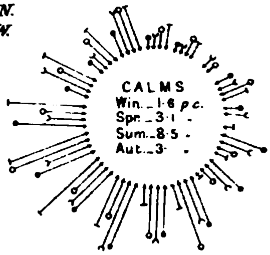
Lat. 52° N.
Long. 15° W.



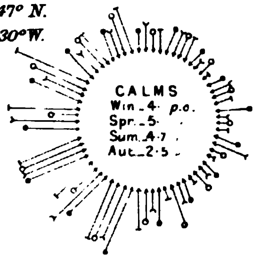
Lat. 47° N.
Long. 20° W.



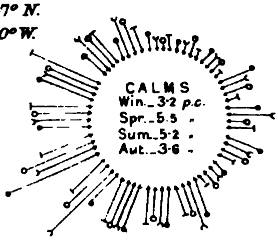
Lat. 52° N.
Long. 25° W.



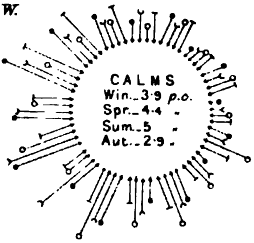
Lat. 47° N.
Long. 30° W.



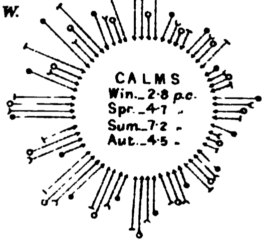
Lat. 47° N.
Long. 40° W.



Lat. 42° N.
Long. 45° W.



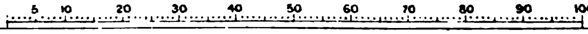
Lat. 42° N.
Long. 65° W.



The arrows represent Winds *blowing toward the centre.*

•—— *Winter* {Jan. Feb. Mar. >—— *Spring* {Apr. May June ○—— *Summer* {July Aug. Sep. ⊢—— *Autumn* {Oct. Nov. Dec.

The length of the arrows is proportionate to the frequency of that wind and the proportion per cent will be given by this scale.



SOUTH

R.H. Laurie, 35, Minories London.

Trades. This was alluded to in the Section on Atlantic Weather (pages 124—128), and will be further discussed, together with the rotatory nature of such storms. The reader is also advised to refer to Section 2, on the Motions and Pressure of the Atmosphere, where full particulars will be found of the causes which lead to the appearance of these storms.

(104.) The most accurate and extensive observations—extensive because continuous—which have been made upon the direction and force of the wind in these latitudes, are those made upon *land*, and especially by self-registering instruments, which have been in operation for a series of years, and give absolutely the quantity and path of the wind passing over the observatory during their operation. But these observations, however excellent, are fallacious; they do not give the *correct* normal direction of the wind, but that of the wind under the powerful influence of the adjacent land and its configurations. This may be obviated by the erection of anemometers on isolated spots, as was done at Bermuda, or any other position distant from any great mass of land.*

(105.) The *Westerly* predominance of the Anti-Trades will be more manifest from an examination of the quantity (or force) of the wind, rather than its prevalence, from those quarters; so that mere *numerical* preponderance gives an imperfect notion of the real proportion of Westerly or Easterly winds. Thus, as before remarked (*) on page 133, the Pilot Charts of Captain Maury and others, though the result of vast labour and of the first importance as grand repertories of facts, are deficient in this respect. A *perfect* Wind Chart is yet to be constructed.

(106.) But there have been numerous analyses of these Wind Charts, combined with observations derived from other sources. We need not further allude to the series of Wind Charts drawn up from Captain Maury's numerical data by Admiral FitzRoy, nor of those arranged by the Netherlands Meteorological Institute at Utrecht, and others previously mentioned (page 125). But there is one essay which is of much importance, published by the Hamburg Meteorological Office (Norddeutsche Seewarte), and translated by our own Meteorological Department, in 1872. It was drawn up by Herr von W. von Freeden, Director of that Office,† and is entitled, "On the Winds, &c., of the North Atlantic, along the Tracks (and from the logs) of North German Lloyd Steamers, between the Channel and New York."

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* On page 103 (14), the question of force, as encountered by ships in *motion*, is alluded to as not giving a correct estimate, as it ought to be the real amount without the effect of the ship's driving before it. The land observations also are modified by the above-mentioned influence. A plan was proposed by Professor Piazzi Smyth, in conjunction with Captain H. Toynbee, to have the wind recorded from the *mast-head*, as the only part of a ship not affected by the eddies from her sails; the direction and force to be communicated electrically to the cabin and there recorded. See "Report of the British Association," vol. xxv., page 45.

† Translated from No. III. of the Mittheilungen aus der Norddeutschen Seewarte, Ueber die Dampferwege zwischen dem Kanal und New York, nach den Journal-Auszügen der Dampfer des Norddeutschen Lloyd, in den Jahren 1860-67. Nebst Wind und Wetter in derselben Zeit. Von W. von Freeden, Direktor.

(107.) We extract the following from the work, premising that the charts referred to have not been copied here.

1. THE WINDS OF THE NORTH ATLANTIC, BETWEEN LAT. 55° AND 40° N.

We have made two Wind Charts dealing with the winds having a force of 0 to 9, Beaufort Scale, of which the first, constructed according to the old system of Maury, contains the aggregate number of observations collected by Maury, Andrau, and the Norddeutsche Seewarte (the Hamburg Meteorological Office), amounting to 55,710 observations, including calms and variables. The second chart exhibits, partly numerically and partly graphically, 16,653 observations, made specially in the routes of the North German Lloyd steamers, during the eight years 1860—1867. From the detailed information given in these charts we condense the masses of figures into closer groups, and elucidate the relative frequency of occurrence of any wind by means of per-centages. In the first place we give—

A.—GENERAL WIND TABLE *for the North Atlantic, between Lat. 55° & 40°, in the Yearly Period, and referred to Eight Points of the Compass.*

Long. W.	Lat. N.	No. of Observations.	Variable.	Calm.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
° °	° °											
5—35	55—50	4,224	45 1 *p.c.*	140 3 *p.c.*	250 6 *p.c.*	364 9 *p.c.*	443 10 *p.c.*	558 13 *p.c.*	712 17 *p.c.*	828 20 *p.c.*	562 13 *p.c.*	322 8 *p.c.*
	50—45	25,454	134 1 *p.c.*	1,078 4 *p.c.*	2,328 9 *p.c.*	2,495 10 *p.c.*	2,283 9 *p.c.*	2,906 11 *p.c.*	3,909 15 *p.c.*	4,220 17 *p.c.*	3,650 14 *p.c.*	2,451 10 *p.c.*
35—55	,,	5,384	86 2 *p.c.*	187 3 *p.c.*	337 6 *p.c.*	379 7 *p.c.*	302 6 *p.c.*	622 11 *p.c.*	917 17 *p.c.*	1,067 20 *p.c.*	864 16 *p.c.*	623 12 *p.c.*
	45—40	8,007	54 1 *p.c.*	376 5 *p.c.*	611 8 *p.c.*	583 7 *p.c.*	721 9 *p.c.*	1,047 13 *p.c.*	1,284 16 *p.c.*	1,399 17 *p.c.*	1,082 13 *p.c.*	850 11 *p.c.*
55—74	,,	12,641	180 1 *p.c.*	555 4 *p.c.*	1,093 9 *p.c.*	1,124 9 *p.c.*	914 7 *p.c.*	1,550 12 *p.c.*	1,900 15 *p.c.*	2,221 18 *p.c.*	1,744 14 *p.c.*	1,360 11 *p.c.*
Total ……		55,710	499 1 *p.c.*	2,336 4 *p.c.*	4,619 8 *p.c.*	4,945 9 *p.c.*	4,663 8 *p.c.*	6,683 12 *p.c.*	8,722 16 *p.c.*	9,735 18 *p.c.*	7,902 14 *p.c.*	5,606 10 *p.c.*

By adding one-half the intermediate points to each of the four adjacent cardinal points (thus, W. = W. + ½ S.W. + ½ N.W.), we find that—

Westerly	winds are	33	per cent.
Southerly	,,	23	,,
Northerly	,,	22	,,
Easterly	,,	17	,,
Calms and Variables		5	,,

The Westerly to Northerly winds are more certain to be found between 35° and 55° W. in higher latitudes, whilst the South to S.E. winds will be met with more frequently in the lower latitudes, below 45° N. Easterly winds are always more prevalent in lower latitudes, corresponding to the preponderance of the Westerly winds in high latitudes.

The distribution in the separate months of the year, and in seasonal quarters, will lead to practically useful results. The following Table shows:—

B.—General Wind Table *of the North Atlantic, between Lat. 55° & 40°, for separate Quarters, and the Eight principal Points, in per-centages of the Wind's frequency.*

Quarter.	Long. W.	Lat. N.	No. of Observations.	Variable.	Calm.	NE. p. c.	E. p. c.	S.E. p. c.	S. p. c.	S.W. p. c.	W. p. c.	N.W. p. c.	N. p. c.
	° °	° °											
Winter. 10,067 observations.	5—35	55—50	946	—	2	5	7	9	16	18	22	18	8
		50—45	4,886	1	3	8	9	10	14	18	17	12	8
	35—55	50—45	952	2	2	6	7	7	12	14	20	17	13
		45—40	1,241	1	8	8	6	8	12	15	19	16	12
	55—74	45—40	2,042	1	2	8	8	5	9	10	19	24	14
Spring. 14,922 observations.	5—35	55—50	905	—	3	7	12	15	15	14	15	11	8
		50—45	7,414	—	4	11	12	11	11	14	15	12	10
	35—55	50—45	1,042	—	3	8	8	6	10	16	18	18	13
		45—40	2,355	1	5	8	5	8	12	16	17	16	12
	55—74	45—40	3,206	1	4	10	10	8	12	13	16	14	12
Summer. 17,377 observations.	5—35	55—50	1,840	—	5	5	6	8	13	19	21	15	8
		50—45	7,071	—	6	8	7	6	9	17	20	17	10
	35—55	50—45	1,787	2	5	5	7	5	13	21	22	12	8
		45—40	2,770	—	6	6	8	10	16	18	20	9	7
	55—74	45—40	4,409	2	6	6	9	9	15	21	17	8	7
Autumn. 13,344 observations.	5—35	55—50	1,033	2	2	6	9	11	10	18	20	15	7
		50—45	6,083	—	4	8	11	11	12	14	15	15	10
	35—55	50—45	1,603	2	3	8	6	5	12	15	19	17	18
		45—40	1,641	1	5	10	9	10	11	12	13	16	18
	55—74	45—40	2,984	1	4	10	8	6	10	12	18	17	14

If we compare—

A. The distribution of the winds *across the entire ocean*, in the yearly and quarterly periods, we see that the per-centages of the winds' frequency vary very much. If the differences of the per-centages, as compared with the mean yearly values, are expressed by numbers five times too great, and if we indicate by — when the quarterly number is smaller, and by + when it is larger than the yearly number, we get (reckoning right across the ocean):—

Quarter.	Variable.	Calms.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
Winter	—1	—7	—3	—5	—2	+3	— 5	+ 5	+12	+ 3
Spring	—4	0	+6	+5	+7	0	— 7	—11	+ 1	+ 3
Summer ...	—2	+9	—8	—5	—3	+6	+16	+ 8	— 9	—12
Autumn ...	0	—1	+4	+1	+2	—5	— 9	— 7	+10	+ 5

We perceive with remarkable clearness the double period of the decrease of the N.E. to S.E. winds in winter and summer, in contrast to an increase of the South to N.W. winds in the same seasons, and conversely an increase of N.E. to S.E. winds in spring and autumn, and a less frequent occurrence of the South to West winds at the same time. The reason why the N.W. and North winds are proportionally less frequent in summer may be because the region of average uniform heating of the oceanic atmosphere then extends beyond 55° N., whilst in all other seasons the limit falls down to 50° N., and so gives the cold polar wind an opportunity of breaking into the warmer equatorial current at, or to the South of, 50° N. But if we look at the distribution of the N.W. and North winds in separate meridional strips, we find them decidedly more frequent in the Eastern parts of the ocean, as far as 35° W. in summer (23 *p.c.** against 21 *p.c.*; 27 *p.c.* against 24 *p.c.*); on the contrary, in the Western parts, as far as 74° W., they occur much less often (16 *p.c.* against 24 *p.c.*; 15 *p.c.* against 25 *p.c.*). Here the summer heating of the European as well as the American continent evidently exerts its influence, and it attracts the cold N.W. wind of the ocean towards the European coasts lying from S.W. to N.E.; while for the same reason it diminishes the frequency of this wind on the American coast, and, on the other hand, must increase the S.E. and South winds (the Tables give 24 *p.c.* against 19 *p.c.*). These explanations as to the causes of the prevailing summer winds on our coasts are here shown by unequivocal numerical values.

B. An enquiry into the distribution of the winds *with reference to longitude only*, seems still called for from our special considerations.

Our General Wind Table gives the following mean values of the winds' frequency; the per-centages are now doubled:—

Longitude.	Variable.	Calms.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
Between 5°—35° W.	2	7	15	19	19	24	32	37	27	18
,, 35°—55° W.	3	8	14	14	15	24	33	37	29	23
,, 55°—74° W.	2	8	18	18	14	24	30	36	28	22

From which it at once appears that between 35° and 55° W., that is, in the middle of the North Atlantic Ocean, the Easterly winds throughout are less frequent than in the districts bordering it to the East and West; that the South winds are equally numerous in all three districts; the remaining winds, between S.W. and North, are decidedly more frequent in the central strip than to the West and East of it.

But if we again compare the per-centages of the same longitudinal section in the year with the separate quarters, and keep to the above notation, we obtain—

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* These figures are obtained by comparing the results for the summer, in Table B, page 173, with those for the year, in Table A, page 172.

1. Between 5° and 35° W., in doubled per-centages.

Quarter.	Variable.	Calms.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
Winter	—1	—2	—2	—3	0	+6	+4	+2	—2	—2
Spring	—2	0	+3	+5	+7	+2	—4	—7	—4	0
Summer ...	—2	+4	—2	—6	—5	—2	+4	+4	+5	0
Autumn ...	0	—1	—1	+1	+3	—2	0	—2	+3	—1

In the Eastern parts of the Atlantic, therefore, the distribution of the winds in autumn agrees for the most part with the yearly mean, whilst the absolute differences are greatest in spring and summer. In winter and summer we find fewer East winds, but more Westerly winds, than in the yearly mean; but S.W. to N.W. winds are more especially prevalent in summer than in the year generally, and the preponderance of the N.W. winds still continues in autumn. On the other hand, we find in spring a strong set of cold Easterly, *i.e.*, continental winds from the Steppes towards the ocean, and the S.W. to N.W. winds must give way to them. This is a detailed confirmation of our above generalizations as to the causes of the N.W. winds in summer. If the sea gets thoroughly warmed in summer, we then have frequent calms near the Channel.

2. Between 35° and 55° W., in doubled per-centages.

Quarter.	Variable.	Calms.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
Winter	0	—3	0	—1	0	0	—4	+2	+4	+2
Spring	—2	0	+2	—1	—1	—2	—1	—2	+5	+2
Summer ...	—1	+3	—3	+1	0	+5	+6	+5	—8	—8
Autumn ...	0	0	+4	+1	0	—1	—6	—5	+4	+3

The small numerical differences in winter and spring are very striking, whilst in summer they are exceedingly high, and in autumn moderate; on the whole, however, they are smaller than between 5° and 35° W. The change of the sign is about the same as before, but it is to be remarked that in summer the N.W. and North winds are, relatively, extremely rare, compared with the South to West winds, whilst in autumn exactly the reverse takes place. The prevalence of Easterly winds in spring and autumn, which was exhibited between 5° and 35° W., is no longer traceable; these winds have exhausted themselves, *i.e.*, generally speaking (for, *e.g.*, in February, 1870, our steamers encountered, in 48° W., the East wind which had come from 60° E., and brought the most severe winter cold over central Germany, which was, by the way, a propagation in a straight line of an Easterly gale, which the advocates of the Cyclone theory have not yet explained); at the best, the N.E. only occurs somewhat frequently in conjunction with N.W. and North, evidently in the closest connection with the decreasing northern declination of the sun.

3. Between 55° and 74° W., in double per-centages.

Quarter.	Variable.	Calms.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
Winter	0	—4	—2	—2	—4	—6	—10	+2	+20	+6
Spring	0	0	+2	+2	+2	0	— 4	—4	0	+2
Summer ...	+2	+4	—6	0	+4	+6	+12	—2	—12	—8
Autumn ...	0	0	+2	—2	—2	—4	— 6	0	+ 6	+6

That the characteristics of summer and winter vary greatly from the yearly mean is seen immediately, and at the same time the almost complete discontinuance of the symmetry in the variation of the wind numbers in winter and summer on the one hand, as compared with spring and autumn on the other. Certainly the Easterly winds fall short in winter, but with them also the Southerly and South-Westerly, and, in their stead, the powerful winds from N.W. and North prevail, which are known to sailors as the dreaded snow-storms. In spring, if the sea cannot rise in temperature as quickly as the flat American continent, owing to the flow of ice over the Banks of Newfoundland, the N.E. to S.E. winds blow on to the land; in summer, the cool S.E. to S.W. winds prevail on the American coast, blowing from the cool sea on to the land, which has been raised to Italian heat, until, at length, in autumn, the cold N.W. wind accompanies the sudden transition to winter. As, in summer, with the increasing Northern declination of the sun, the Gulf Stream also advances some degrees to the Northward, calms are not rare, owing to the greater equality of temperature between land and sea.

The task now remains to us—after having investigated the distribution of the Winds, so important for general climatology, according to longitude—to prove whether, for the practical purposes of navigation (and we always keep in view the interests of sailing vessels as well as steamers):—

C. The distribution of the winds *according to latitude and longitude* leads to results which are worth notice.

The question now presents itself whether a ship, in any certain season of the year, should keep a decidedly or partially Northern or Southern course from and to America, and what she should do in any certain position if overtaken by contrary wind or gale.

We have only to deal with the general question what answer should be made for the separate *quarters* of the year. With this object we shall investigate for each longitudinal section the simple per-centages of the winds to the North and South of the latitudes under consideration. If the Southern zone has a less per-centage than the Northern, we shall denote the same by the sign —, and the converse by the sign +.

1. Between 5° and 35° W., in doubled per-centages.

Quarter.	Variable.	Calms.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
Winter	+2	+2	+6	+4	+2	—4	0	—10	—2	0
Spring	0	+2	+8	0	—8	—8	0	0	+2	+4
Summer ...	0	+2	+6	+2	—4	—8	—4	— 2	+4	+4
Autumn ...	—4	+4	+4	+4	0	+4	—8	—10	0	+6

The differences increase steadily from winter and spring until autumn, otherwise they are pretty equal. Therefore, in winter, we have to expect more Easterly winds to the South of 50° N., and fewer South to N.W. winds, than to the Northward of 50° N.; in spring, the N.W. to N.E. winds prevail to the South of 50° N., while the S.E. and South winds greatly decrease; also in summer, where the S.E. to West winds are in the minority, and the same in autumn, where to the South of 50° N. the North to N.E. winds and South winds are in the minority.

Accordingly, on an average, outward-bound vessels would do better to keep to the Southward of latitude 50° N., and homeward-bound ships would mostly stand a better chance to the Northward of 50° N. Of course we exclude the special conditions of each month, which may be worked out in the same manner as the above results for seasons.

2. Between 35° and 55° W.

Quarter.	Variable.	Calms.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
Winter	—2	+2	+4	—2	+ 2	0	+2	— 2	—2	—2
Spring	+2	+4	0	—6	+ 4	+4	0	— 2	—4	—2
Summer ...	—4	+2	+2	+2	+10	+6	—6	— 4	—6	—2
Autumn ...	—2	+4	+4	+6	+10	—2	—6	—12	—2	0

In this strip the differences increase considerably until autumn; in all the seasons we find fewer West to N.W. winds to the South of 45° N. than to the North of it, so that a ship desirous of avoiding inconvenience from South to S.W. winds, has only to hold off to the Northward in order to continue her outward course on the starboard tack with success. In summer and autumn especially we find more N.E. to S.E. winds to the South of 45° N. than to the North of it, but of course it must not be forgotten that the absolute frequency of Easterly winds is generally less than the Westerly.

(108.) Captain H. Toynbee, the Marine Superintendent of the Meteorological Department of the Board of Trade, made a rigid examination of a very important series of logs, kept by Captain J. A. Martyn, of the Royal

Mail Steamers' tracks between the Channel and New York.* There were eight of these logs, and for each of them a separate diagram was made (which cannot be given here), exhibiting the character of wind, weather, barometric pressure, air and sea surface temperature, the specific gravity of the sea-water, and the readings of the dry and wet bulb thermometers. Being thus uniformly arranged, a series of important deductions was derived from their teachings by Captain Toynbee, which bear out in a remarkable degree the observations previously made by Sir John Herschel and Mr. Birt, on *Barometric Waves* (see (36) and (37), pp. 116—117 ante).

(109.) Captain Toynbee remarks:—Having considered the eight diagrams, I propose giving a few more facts before drawing any conclusions.

First, the peculiar undulations in the barometric curves, accompanied by corresponding changes in the wind, weather, and temperature, are quite in accordance with the experience of seamen in corresponding Southern latitudes; there, from the latitude of the Cape of Good Hope down to 55° S., a similar series of changes is experienced, the winds commencing at North and ending at West or S.W.; it will be borne in mind that in this case the South is the polar wind. There, also, ships running to the Eastward seem to keep company with a Westerly gale, so that the wind continues from the same quarter for days.

With the object of discovering the breadth of these belts of Southerly wind accompanied by a decreasing pressure, and of Westerly wind accompanied by an increasing pressure, I have calculated the number of geographical miles which the ship steamed to pass through them, and find from seven of those on diagram 1, that each belt occupied about 20 hours, and the ship steamed about 150 miles; also, that in diagram 1, the Westerly wind belts were about as broad as the Southerly ones. Now, by referring to the homeward passages, it will be seen that the steamer often kept in the same wind for days together, and in some cases had a decreasing pressure with a North-Westerly wind, and an increasing pressure with a Southerly wind; it therefore seems probable that she then kept pace with the general motion of the gale to the Eastward, and, in fact, sometimes outstripped it, so that we can hardly be wrong in estimating that these systems of winds were travelling to the Eastward at least at a rate of about eight miles an hour; hence, on the outward passage, whilst the ship steamed 150 miles to the Westward, the gale, by a rough estimate, may be said to have moved about 150 miles to the Eastward, giving a breadth of about 300 miles for each of the Westerly and Southerly wind belts.

(110.) The accompanying quotation from a letter I received from Captain R. Inglis, Marine Superintendent to the Cunard line of steamers, contains the opinion of one who has had great experience in Atlantic weather. He thinks that the Westerly winds of the Atlantic are caused by the meeting of two currents of air; whether he be right or not, his facts are very interesting. Writing from Liverpool, he says:—"Between this country and New York is the route of which I have had most experience, and the locality in which we have the most interest here." . . . "Drawing a line N.E. from the Caribbean Sea clear of the Coast of Florida, it would cut our track to New York between the meridians of 40° and 50° W.; this will be found to be the Western limit of the great S.W. Equatorial current; this current of air from the S.W. touching the earth is now brought into contact with the North wind flowing to the Southward, and the steady flow of the two currents, upper and lower, is interrupted; the Northerly current in the latitude I have named will then have a course from nearly due North, certainly not past N.N.E., the Southerly current of air will be S.W., therefore, by coming into collision, an almost continuous Westerly wind will blow between 40° W. and England." . . . .

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* "Report on the Meteorology of the North Atlantic, between the parallels of 40° and 50° N.," by Captain Henry Toynbee, 1869.

"Having accepted this theory, I determined to put it to a practical test, when commanding the screw steamer *Alp*, in 1857. It so happened that whilst making a passage from Havre to New York we fell in with a heavy gale of wind from the Westward, and it occurred to me that the wind being West I was in the line of contact, so that if my theory were correct, the more I steered to the Northward the more the wind would norther. We were steering West, so I put the ship's head off to N.W., and set the fore and aft sails; the ship's way increased, and in twelve hours the wind hauled sufficiently to the Northward to enable me to lay my course on the starboard tack; by attending to this we beat the *Africa*, one of our powerful mail boats, a whole day.

"Again, coming from New York, we often fall in with a S.W. gale, with the weather bright and clear; this will continue for one or two days, how long depends upon the northing we are making; if the ship is going due East she may carry the S.W. wind right across the Atlantic; if she is making northing she will fall in with drizzling rain; when this occurs, *look out*, for the wind will fly round to N.W. suddenly. This has become a saying with sailors navigating the Atlantic, and it is always so, for then the ship is approaching the line of contact; the S.W. wind being warm and laden with moisture is coming into contact with the cold North wind, condensation ensues, and rain is the consequence. After the shift to N.W. we have squalls of hail; finally, as the ship gets to the Northward, the wind hauls to North, and we have fine clear weather.

"This, as a rule, is a true explanation of the steady gales we meet with in the Atlantic, which, in mid-ocean, last for six or seven days; but this is not always the form which these two currents take, very often we meet with rotary storms of small circumference. When steaming out to the Westward we often meet with these circlets, if I may so name them; in them we have the wind from all points of the compass during the twenty-four hours, with rain and dirty weather, not blowing very hard, but still disagreeable; this may last three, four, or five days; now these rotary storms are all going on at a rapid rate to the Eastward, and finally strike our coast; they are occasioned by the opposing currents of air being of unequal force, and would naturally resolve themselves into the rotary form.

"It is a singular thing to note that this current of air very rarely touches the Coast of Spain; the times in which they have a S.W. gale on the Coast of Spain, South of Cape St. Vincent, during a year, might be counted on your fingers.

"On the contrary, I have no hesitation in saying that during eleven months of the year there is a strong Northerly wind blowing down the Coasts of Spain and Portugal, and further the prevailing wind in the Mediterranean is from the North, and this is the way I account for the supply of air being kept up that is necessary to fill up the vacuum caused by the air ascending near the Line.

"If this theory be true, it follows that the great object of gathering the data you wish our captains and others navigating the Atlantic to collect, will be to determine where the line of contact is at the different seasons; of course it will vary North or South according to the declination of the sun.

"It would be of immense benefit to us to know that, on the passage out, by keeping to the North we should ensure Northerly winds, and that during the homeward passage a more Southerly course would keep our ships in a South-Westerly wind."

(111.) It seems quite clear that the steady Westerly winds spoken of by Captain Inglis were experienced during the passage home, whilst the quick changing circlets to which he alludes were met with on the outward passage, which facts are borne out by Captain Martyn's log; and the natural conclusion is that homeward the ship was *moving with* a wave or system of weather, whilst outward she met several such waves.

(112.) **Temperature, &c.**—It is a curious coincidence that the spot which Captain Inglis speaks of as the Western limit of the great South-Westerly Equatorial current of air is the position of the Eastern edge of the first cold water met with on the outward passage, and where Northerly disturbances seem to be very common in the wind.

The effect of the Temperature of the surface water on the wind and weather seems to be a phenomenon of universal occurrence; in the warm water on the Eastern edge of the Agulhas Bank the wind is notoriously unsteady, insomuch that however fresh and fair the wind may have been to a ship coming from the Eastward, she is almost sure to get baffling unsettled weather in this warm water, and the clouds have a more tropical doldrum appearance: whereas, in the patches of cold water in the Southern Hemisphere, hail squalls from the S.W. are common (see my paper on the Specific Gravity, Temperature, and Currents of the seas passed through during five voyages from England to India, read before the Royal Geographical Society, May 8th, 1865), just as hail and snow-storms from the N.W. are common in the cold water to the Eastward of North America, and ships are said to run out of it into the warm water of the Gulf Stream to refit after a fight with a winter gale. In fact, over cold and warm water in close proximity, we have the same forces in operation as those which enable land and sea-breezes to reverse the prevailing wind of the season; and if atmospheric pressure relatively increases over cold water, then according to Buys-Ballot's Law, there would be a tendency to Northerly winds on the Eastern edge of a patch of cold water in the Northern Hemisphere, whilst Southerly winds would be more prevalent on its Western edge, unless its effect be masked by greater influences.

It will be noticed that from England to about 40° W. and 47° N. the surface temperature is very uniform; in diagrams 5 and 6 this uniform temperature extends farther West; then in about 49° W. a patch of cold water generally exists, after which streaks of warm and cold water were met with. On reaching longitude 65° W., a sudden decrease took place in the temperature of the surface water, with water somewhat warmer farther to the Westward.

The Specific Gravity is a difficult observation to make on board ship when there is much motion. Captain Martyn and Captain Watson frequently found the water warmer at 20 feet deep than at the surface, which, taken together with the fact that the cold water has the least specific gravity, makes it possible that the Gulf Stream passes under this cold water on its way to the North-Eastward.[*]

(113.) The dry and damp bulbs show clearly that the West and N.W. winds were generally the driest experienced during the eight passages, but there happened to have been very little Easterly wind. There are some striking instances of extreme dryness in air which, having passed over cold, was then over warm water.

2. STORMS IN THE NORTH ATLANTIC OCEAN, BETWEEN LAT. 40° & 55°.

(114.) A careful study of any series of the North Atlantic Weather Charts will show that Northward of the Trades the general tendency of atmospheric disturbances is from West to East, or from W.S.W. to E.N.E. Nevertheless, there is no certainty that any Storm met with will follow the usual path; it may suddenly turn off in a different direction, or may disappear altogether. They also vary greatly in their area; one may cover the whole extent of the Northern Atlantic Ocean, while another may be of very limited dimensions. Many vessels widely apart may be involved in the same disturbance, or two vessels, comparatively close together, may meet with totally different weather. One may be experiencing a violent gale, of which the other may be in complete ignorance. This variation, in the shape and size of a Storm system, is one of the most harassing uncertainties with which the navigator has to deal. He knows by careful watching of his barometer that there is bad weather in his immediate vicinity, he ultimately decides his position with regard to the approaching disturbance, but the magnitude, limits, and intensity he can know nothing of until he has experienced its extent and felt its violence.

Several storm areas travelling to the Eastward sometimes follow one another in quick succession, moving along their path at an average speed of 18 to 20 miles an hour. In this case, vessels bound in opposite directions would apparently meet with different weather at the same time in

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[*] In Captain Watson's last log I find the following entry:—March 27th, 1869, position at noon, lat. 40° 42′ N., long. 63° 28′ W.

Noon,	surface temperature	67°;	specific gravity	1·0270
2 p.m.	„	38°;	„	1·0260
4 p.m.	„	38°;	„	
5 p.m.	„	52°;	„	1·0265

(The ship was steaming to the Eastward).

Here there were two sudden changes of Temperature and Specific Gravity in a few hours. The correction for Temperature has not been applied to the Specific Gravity observations; it would have increased the difference between those of the warm and cold water.

the same place. A vessel bound from Europe to America would pass through a succession of heavy gales, while a powerful steamer homeward bound might outstrip the gale, or remain involved for days in one storm system.

(115.) "We are, then, in possession of facts to prove that between the latitudes of 35° and 50° of both hemispheres the air commonly moves to the Eastward in a series of gales or systems of wind, which commence with an equatorial wind, increasing temperature, and decreasing pressure; that during a heavy shower of rain, when the pressure is at its lowest, the wind shifts suddenly to a Westerly or even more polar direction, accompanied by a sudden increase of pressure and decrease of temperature, and commonly followed by finer weather. This is so thoroughly understood by experienced seamen, that when the pressure is decreasing fast, with an equatorial wind, and a heavy shower of rain comes on, accompanied frequently by a lull in the wind, they prepare for the sudden shift of wind, which generally comes in a gust.

"It seems probable that these systems of wind, which have such regular habits, are waves of air rolling along to the N.E. in the Northern, and to the S.E. in the Southern Hemisphere; that in their front the warm air is rising, and losing part of its moisture and weight by condensation, until a climax of low pressure comes, which is immediately followed by a *downward* rush of cold air, forming a West or N.W. wind, causing the heavy shower of rain or hail when it first comes in contact with the lower warm air; also an increasing pressure and decreasing temperature.

"The North-Easterly direction taken by these waves, would most likely be due to the existence of a lower pressure over the Northern part of the Atlantic than over the land to the Eastward of it; whereas the changes of wind from South by the West to N.W. would be due to the internal action of the wave as it sweeps along; a section of the wave would represent a kind of revolving motion in the air, with its lower edge pressing on the earth's surface, whilst its upper edge is well inclined towards the Pole.

"Professor Buys-Ballot says:—'It is certain that, if after an unfavourable condition of pressure a S.W. wind has set in, which has veered with stormy weather towards N.W., we find that generally a very unfavourable condition, and usually the greatest difference, will be observed next day, without being followed by fresh wind.' May not this be because part of the North-Westerly wind is a downward motion instead of its being horizontal?

"During Captain Martyn's outward passages (to which reference has been made in (108)) he had a decreasing pressure with a Southerly wind, and an increasing pressure with a Westerly and North-Westerly wind, showing that he was meeting gales; whilst during his homeward passages he had the pressure and wind steady for days together, showing that he was either moving to the Eastward about as fast as the gale, or steaming faster than the gale was moving, and had a decreasing pressure with a Northerly wind, and an increasing pressure with a Southerly wind, caused by his entering these systems of wind on the opposite side to what he did on the passage out.

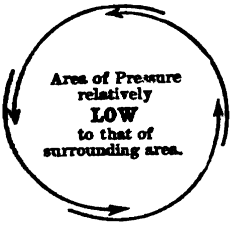
"The setting in of a Southerly wind with a decreasing pressure immediately after a North-Westerly wind on the outward passage is illustrated by the diagrams,* which explain the nautical saying that the wind backs to blow. Experience shows that the common habit of the wind in these latitudes is to back from N.W. to South, the exception being when it completes the circuit and goes to North and East."

(116.) Captain Toynbee, in his pamphlet on "Weather Forecasting," remarks:—Systems of low barometric pressure change their positions and sometimes move very quickly, generally having a high barometer to their right and a low barometer to their left as they proceed along their tracks. Considering the general disposition of barometric pressure in the Northern part of the Atlantic, which has been alluded to in (25), we have the reason why the Atlantic storms generally move along an Easterly track, and often diverge to the North-Eastward as they approach our islands; in fact, they have a tendency to move as subsidiary systems round the South and East sides of a prevailing area of low barometric pressure which has its centre somewhere to the Southward of Iceland.

(117.) **Cyclones and Anti-Cyclones.**—Before proceeding farther with this subject, it is necessary that some description should be given of the two classes of atmospheric disturbance, to which several allusions have been made in the preceding pages, especially in Section 2, on "The Motions and Pressure of the Atmosphere," pages 108—124. Farther on, when we describe the Winds of the British Isles, we shall give further particulars respecting them, illustrated by diagrams showing the distribution of Clouds and Weather.

(118.) **Cyclones.**—The term "Cyclone," says Mr. Ley, "was originally only applied to the Hurricanes of the lower latitudes, but since the laws which connect the wind with the distribution of pressure have been shown to be universal, it is obvious that around any area of reduced pressure the wind must circulate in the same general way as it circulates in a Tropical Hurricane. Now the areas of reduced pressure, though subject to great variety of figure, approximate, generally speaking, to circular or oval forms, as we should, from our general knowledge of the motion of fluids, expect to be the case. All such systems of reduced pressure, and their co-existing systems of currents, are therefore spoken of as "Cyclonic."†

In a Cyclonic system, in the Northern Hemisphere, the wind blows round a central area of *low* barometric pressure, in a direction contrary to the hands of a watch, drawing slightly *inwards* towards the centre, as shown in the accompanying diagram. From this the inference is drawn that within a relatively low barometric area the air is *ascending*, consequent on the condensation of aqueous vapour over a large area, while the surrounding air is forced in by the higher pressure upon it.



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[*] "Report on the Meteorology of the North Atlantic, between lat. 40° and 50° N.," by Captain H. Toynbee.

[†] "Aids to the Study and Forecast of Weather," by W. Clement Ley, M.A.

Mr. Ley remarks:—"The district in which the condensation is most active occupies the front of the Cyclone. A little consideration will show that over the North Temperate Zone it is on the Eastern side of a Cyclone that this condition will in ordinary cases occur, since it is on this side that we have Southerly winds, while these winds, in moving from warm to colder regions, experience a diminution in their capacity for holding water vapour.

"A Cyclone must not therefore be regarded as a revolving disk, the whole of which is propelled over the earth's surface, but rather as an eddy of spirally ascending air, which eddy is being constantly reproduced on one side of its original position. Fresh portions of the atmosphere are thus perpetually thrown into cyclonic circulation, and it is only by a metaphor that a progressive Cyclone can be said to preserve its identity during its progress.

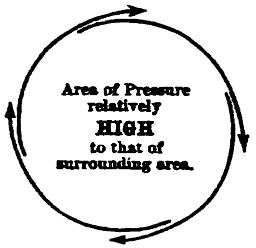
"Cyclonic systems exhibit the tendency to run in a series, a fact which it is difficult to explain, if a Cyclone is regarded simply as a revolving disk. When the atmosphere over an extensive district is much charged with water vapour, the formation of a large nimbus is sufficient to originate a Cyclonic system; but a considerable portion of the atmosphere which is drawn into the circulation never reaches the front of the Cyclone at all, being left behind, as the Cyclone is rapidly developed over another part of the earth's surface; this part of the atmosphere, therefore, falls calm before it has parted with its aqueous vapour, and is in the condition favourable for the propagation of another system.

"An objection to the condensation theory of Cyclones is occasionally drawn from the fact that *in some cases* both heavy and extensive rainfall is found to occur in the immediate rear of a centre of depression, when travelling Eastwards. Recent investigations, however, render it probable that the axis of a progressive Cyclone is commonly so inclined, that at the height of a few thousand feet above the earth's surface the area of least pressure lags considerably behind the area of least pressure observed at the earth's surface. It will therefore occasionally happen that, *over* the wind which blows in the rear of a depression, currents flow *in nearly an opposite direction* to that wind. These latter currents consequently precipitate their water through the lower stratum of relatively dry air."

Bearing of the Centre.—In accordance with Buys-Ballot's Law, a person standing with his back to the wind, in the Northern Hemisphere, near any low barometric area, will have the centre *about* two points to the front of his left hand, or, in other words, with a ship running before the wind, *about* two points before the port beam. By the direction of the wind he may know in what part of a Cyclonic area his vessel is; by his barometer he can tell whether the centre is approaching or leaving him; and knowing the usual track of such Storms he can manœuvre so as to avoid the centre. (See the Section on Hurricanes or Tropical Cyclones hereafter).

As the Cyclone moves along its course, it is evident that the barometer will be falling more or less at every portion of the front, and rising more or less everywhere in the rear, so that there must be a line of places somewhere across the Cyclone where the barometer has touched its lowest point and is just going to rise. This line is called the "trough" of the Cyclone.

(119). **Anti-Cyclones.**—In (34) an Anti-Cyclonic system is described as an area of relatively *high* barometric pressure, around which, in the Northern Hemisphere, the wind blows with watch-hands, *i.e.*, contrary to what it does in a Cyclone, but drawing slightly *out* from the centre, as shown in the adjoining diagram. It is conjectured that within such an area the air is *descending* from higher regions, and spreads out over the lower barometric areas surrounding it.



Mr. Ley remarks:—"An Anti-Cyclone represents the position of a downward movement of the air, which has lost the greater part of its water vapour in previous Cyclonic circulations. In the district, therefore, near the central calm of an Anti-Cyclone, the currents take up instead of precipitating vapour; this explains why it has no principle of progressive development (or forward movement). The Anti-Cyclone presents a great contrast to the Cyclone in this respect, that instead of shifting their geographical position rapidly, they are exceedingly sluggish in their movements; and, indeed, frequently remain stationary for a very considerable period.

(120.) "Here the reader is warned against another possible misapprehension. The terms 'Cyclone' and 'Anti-Cyclone' do not refer to the *actual* level of the barometer within the areas to which they are applied, but to its level *relatively* to the level in surrounding districts. The observer may find the mercury in his barometer above its mean height (23), and yet may *possibly* be situated at the centre of a Cyclonic system at the time, because the mercury may be still higher at all stations at a certain distance from his own. Contrariwise he may find the mercury in his barometer below the mean, and yet may be at the centre of an Anti-Cyclone, because the barometers on all sides of his station may have lower readings at the time than his own."

(121.) Captain H. Toynbee, in his pamphlet "Weather Forecasting for the British Islands," published in 1890, remarks: "It is clear that winds from all directions blow in connection with each of these systems. For instance, both have a South wind, but with very different characters. In the case of a Cyclonic or low barometer system, the South wind is on the Eastern side, where the air is rising and having its vapour condensed into cloud and rain, by which heat is given out. In the case of an Anti-Cyclonic or high barometer area, the South wind is on the Western side, where the air is descending and is comparatively cool and dry, having a tendency to take up moisture instead of giving it out.

"Between the South wind on the Western side of an Anti-Cyclone and the South wind on the Eastern side of a distant Cyclonic area, there will be a prevailing Southerly wind, and in passing from the high to the low barometric area, a position will be come to where the air will cease to descend. As the low pressure area is approached, the ascending air will be entered, and clouds and rain will be experienced.

"Experience shows that when a storm-centre has passed away, it is frequently followed by a mere ridge of relatively high barometer; between which and the storm which has passed away the wind has veered from S.W. to West and N.W., accompanied by a fast-rising barometer and generally very fine weather. The first indication of there being another storm to the Westward of the ridge is given by the appearance of *cirrus* clouds, which generally move from the N.W. or West. When the crest of the ridge has passed, the barometer begins to fall, and the wind backs to the Southward of West as the Eastern side of the incoming storm-centre approaches the observer."

(122.) The following remarks are taken from the section on Cyclonic Gales of the North Temperate Zone, given in the "Barometer Manual."

These gales generally commence at South, and end at West or N.W., with little or no East wind. The probable reason of this is that the areas of low pressure to which they are related have steep gradients only on their East, S.E., South, and S.W. sides, there being little or no difference of pressure between their centre and the more permanent depression which lies to the North of them.

Whenever areas of both high and low pressure are liable to pass over any region it is obvious that the direction of the wind, taken alone, will not be a sufficient guide as to what weather is to be expected. If, for instance, in the Northern Hemisphere, an area of *high* pressure be passing off to the Eastward, the wind in the rear of it will veer through S.E. to South. Although this direction of the wind shows that the barometrical readings are lower to the Westward than to the Eastward, it is not by any means an indication that a serious diminution of pressure, which may possibly bring a Storm with it, is approaching, although the wind in front of such a depression would be Southerly also. It is therefore necessary in such circumstances to look for other signs, besides the mere direction of the wind, when striving to foresee what is coming.

Moreover, it must always be remembered that, although it is most commonly in connexion with considerable falls of the barometer that severe Storms are experienced, yet the sudden large increase of pressure which not infrequently follows such depressions, or takes place in their proximity, may be accompanied by very violent winds. Caution, therefore, will always be requisite on the occasion of any sudden change of pressure, whether it be in the direction of increase or decrease.

The Cyclonic Storms of the Temperate Zones do not often present the phenomena of a central calm, with the winds blowing from nearly opposite directions on each side of it. There is, therefore, not so much risk of being taken aback as in the Tropical Cyclones; the tack on which it will be safest to lie-to, if obliged to do so, will be the same as that for the Cyclones (to the Chapter on which the reader is referred).

The most serious sudden shift of wind which is to be expected in these Storms is that from S.W. to N.W., in the Northern Hemisphere. This is generally accompanied by heavy rain or hail, with thunder and lightning, while the temperature falls several degrees with the first blast of the N.W. wind.

In considering how to act in such circumstances, there are two matters to which the seaman's attention should be directed, as they seriously affect the conclusions he should draw from his barometer readings.

The *first* is that on the one tack his barometer has a tendency to rise, on the other it has a tendency to fall. The tack of rising barometer is the starboard in the Northern, the port in the Southern Hemisphere. This may be explained as follows:—

According to Buys-Ballot's Law, in the Northern Hemisphere, the lower barometer is on your left when your back is turned to the wind, and as when you are thus placed a ship on the starboard tack is advancing towards your right, she goes towards the higher barometer and recedes from the lower. In the Southern Hemisphere this is reversed. But this rule will only be strictly applicable so long as no change takes place in the barometric pressure, and it may so happen that a high pressure towards which the ship is going may be receding from her faster than she sails, and a lower pressure may be coming up astern and overtaking her; or it may be that a lower pressure towards which the ship is sailing may be moving away faster than she sails.

Still the influence of the tack must always be felt, and on the whole it may be said that in the Northern Hemisphere, a rising barometer on the starboard tack is not a sufficient indication of improving weather, and other signs should be looked for before trusting it. In all cases for the Northern Hemisphere a rising barometer on the port tack is a valuable indication of improving weather, while a falling barometer on the starboard tack is an important warning in the other direction. This order is reversed in the Southern Hemisphere.

The *second* point to consider is the relation which the course and speed of the ship bear to the tracks and progress of the areas of low barometric pressure and their corresponding wind systems, in parts of the ocean where the general tracks of Storms are known.

Ships bound Westward across the Atlantic meet the advancing Storm systems, and when homeward bound run with them; consequently, the rapidity with which the barometer falls or rises and the wind shifts is proportionately greater in the former case than in the latter.

(123.) From the same pamphlet we make the following extracts concerning the ordinary Gales of the North Temperate Zone.

The ordinary gales of the North Temperate Zone commence at S.E. or South and end at West or N.W. The following may be cited as an illustration of what frequently occurs to a sailing ship. A homeward-bound ship, in about lat. 45° N., long. 30° W., falls in with a fresh Southerly wind, and from what has been said, the captain knows that there is a lower pressure to the West of him, and he may safely consider that it is travelling to the Eastward; but his ship is also going East, and his barometer may remain steady, or even rise if he is outstripping the low pressure in its advance.

In the event of having to heave-to, the amount of fall in the barometer per hour is a good though not certain guide; a fall of ·04 to ·10 of an inch per hour is usually considered to be a serious indication of the approach of a Southerly gale, which may be followed by an equally fast rise, accompanied by a West or N.W. gale.

With a Southerly wind and falling barometer, a ship bound to the Westward might gain by running to the Northward with the object of causing the wind to back to the Eastward, but the type of gale in which this is possible resembles a Cyclone, and does not represent the ordinary gales of these latitudes which begin at South and end at West or N.W. Again, it might be possible for a ship, with the first of the Southerly wind which exists on the East side of the area of low pressure, to get less wind by running to the North, but as the extent in latitude of the Cyclone area is not known, and as there is no certainty that she would get into more moderate weather by doing so, she might do herself more harm than good.

It seems, then, probable that a ship bound to the Southward or Westward must face one of these gales if she meets it. A weak ship, whose object is to stem the sea and get safely through, without considering progress, should lie-to on the starboard tack, as the wind generally shifts from South to S.W., West, and N.W. This would of course be the best plan for any ship which found the gale too heavy for her. But a well-conditioned ship, bound to the Westward, may keep on the port tack until the wind shifts to West with a rising barometer, and then tack to the South-Westward. This plan would, of course, tend to bring her into the trough of the sea, and she would be more likely to be caught aback as the wind changed, but we are assuming that her captain will be prepared to meet these risks.

When the wind has shifted to N.W., the starboard tack takes her away from the centre of such a disturbance, though she may soon sail into the Southerly wind of the Eastern side of another low-pressure area coming towards her. This would be a very common occurrence in winter.

(124.) Captain H. Toynbee, in the pamphlet mentioned in the note on page 178, remarks :—There are some practical questions respecting these gales which are of great importance to seamen, one of them being : When a ship is bound to the Westward, and meets the Southerly wind on the Eastern edge of one of these gales, can she bring about a more favourable wind by running to the North, or otherwise manœuvring, or must she undergo all its changes from South by the West to W.N.W. or N.W. as it is sweeping by her to the Eastward ?

We are not without evidence leading to the supposition that there is a polar limit to these Westerly gales ; for instance, Buchan, in his "Handy Book of Meteorology," gives a Table of the prevailing winds in January, which shows that Iceland has about an equal amount of wind from all directions, whilst the prevailing wind in Greenland is Easterly, and in Newfoundland North-Westerly. The Meteorological Journal of H.M.S. *Rattlesnake*, Captain Trollope, R.N., shows that when she was frozen up in Port Clarence, Behring Strait, during the winter of 1853 and 1854, she experienced North-Easterly winds for two-thirds of the time.

It seems probable that Westerly gales are not so common in 60° N. or S. as they are in 40° or 50°, so that, other circumstances being equally favourable, the higher latitudes are the better for making *westing*. It is common with seamen to call the zone between lat. 40° and 50° "the Roaring Forties," which seems to support the above idea.

If these Westerly gales extend over several degrees of latitude, there does not seem to be any chance for a ship bound Westward to bring about a change by manœuvring until they have swept by, and if the wind is not so strong as to make a beam sea dangerous, the best plan seems to be to follow Captain Inglis' example (110), and in the Northern Hemisphere to stand on the port tack until the wind shifts to West or N.W., when the starboard tack would be the most favourable.

Then, again, the strength of these gales certainly seems to bear some relation to the amount of atmospheric depression; but gales that commence at South and end at West or N.W., with an absence of Easterly winds, cannot be dealt with as ordinary Cyclones, though there can be little doubt that the starboard, being the "coming up" tack, is the best to lie-to upon in the Northern Hemisphere, as it enables a ship to stem the sea.*

(125.) The Report of the Director of the New York Meteorological Observatory for 1872 contains some interesting information respecting Storms in the North Atlantic Ocean. Charts are constructed in the Observatory, illustrating the progress and direction of barometrical and thermometrical waves crossing the United States, and the influence exercised by them on the regions which they pass, and endeavours have been made to trace from these data the progress of American Storms across the Atlantic, and to predict the time of their arrival on the European coasts. For this purpose the registers at the New York Observatory were compared with those kept at Valentia and Falmouth, distant about 3,100 miles, and it was thus found that there are many atmospheric waves which traverse the Atlantic, and that within certain limits the times of their passage may be pretty accurately predicted. "If, in the case of a Westerly wind, which is travelling about 200 miles in twenty-four hours, the exact time be found at the lowest reading of the barometer, and the speed be ascertained for 24 hours before and after that time, the mean of these two numbers will give the true rate of the storm in 24 hours. Thus, if 4,200 be divided by the number thus found, the result will be the number of days which the Storm will take to cross from New York to Valentia or Falmouth." An actual example of the application of this rule is given, and is worth quoting:—"On the 4th of October, 1869, there occurred a low barometer at the New York Observatory at 1 p.m. In the 24 previous hours the wind had travelled 313 miles; and, in the 24 succeeding, it made 286 miles. The mean of these numbers is 299, by which, if 4,200 be divided, the result is 14 days for the passage of the Storm across the Atlantic." This calculation was exactly right, for the Storm arrived at Falmouth on the 18th of October.

It is stated in the report that, from the year 1869 to 1872, the computations made respecting 86 atmospheric disturbances expected to cross the Atlantic failed in only three instances to give accurate results. Further experience since that date has not been so satisfactory, and our own Meteorological Office has given up for the present any attempt at predicting Storms crossing the Atlantic. It is impossible to say that any Storm leaving the American shore will reach us, and, if it does, what part of the European coast it will first strike.

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* It is not within the province of this work to advise the commander how to manœuvre his vessel in stormy weather, as he must naturally be the best judge of her behaviour and capabilities under the stress of wind and sea. We may, however, call attention to a correspondence in the "Nautical Magazine," 1882 and 1883, regarding the management of screw steamers when lying-to, *with engines stopped*. The *Illinois*, wfth engines disabled in a storm, safely lay-to for 12 hours, with the wind and sea from two to four points *abaft the beam*, and on another occasion successfully repeated the same operation. See, also, the Remarks on the Use of Oil in Storms at Sea, given hereafter.

Captain Hoffmeyer, of the Danish Meteorological Office, in a pamphlet published in 1880, discussed 285 Storms, which occurred during a period of 21 months. The results seem to show that only about 25 per cent. of our Storms could possibly have been telegraphed from the United States. Of 59 Storms which left the American coast in 1879, 37 (63 per cent.) crossed to Europe, the time across averaging five days, or about 18 miles an hour. The late Professor Loomis, the celebrated American meteorologist, from his observations, considered that 47 per cent. of the Storms which left the American coast arrived on the European coast, and he states, in one of his Contributions to Meteorology, that "when Storms from the American continent enter upon the Atlantic Ocean, they generally undergo important changes in a few days, and are frequently merged in other Storms which appear to originate over the ocean, so that we can seldom identify a Storm in its course entirely across the Atlantic."*

(126.) In the publication of the Meteorological Office mentioned below,† and in any series of Weather Charts published, the fact of Storms travelling Eastwards is very lucidly shown in the diagrams by the daily positions of the isobars; and in the remarks given hereafter on the Winds of the British Isles, some further remarks will be found, showing that the progress of the main body of the air is to the North-Eastward across the British Isles. That it occasionally travels to the South-Westward is also mentioned.

The chart for each one of the 11 days embraces the observations of about 30 ships, together with those of many land stations. Captain Toynbee draws the following conclusions from the study of these charts.

1. As to the origin of the numerous gales experienced during the 11 days with which we have been dealing.

By referring to the charts it will be seen that almost invariably there was a Northerly wind on the American coast, and a Southerly wind at some distance to the Eastward of that coast. This state of the wind, considered in connection with Buys-Ballot's Law (page 113), requires that there should be a trough of low pressure between two high pressures. Buchan's Monthly Charts of Isobars,‡ giving the mean pressure over the globe, show that the above is the case in the months of January and February. The January chart shows the isobar of 30·2 over the American land, and again over the sea just to the Northward of the N.E. Trades, and we know that between these high pressures the hot Gulf Stream flows, which may well be supposed to cause an unusually low pressure, for, other circumstances being the same, it is found that the barometer is lower over warm than over cold water. For instance, the meteorological data of the 10° square between the Equator and 10° N., and from 20° to 30° W., show that the lowest pressure exists over the hottest water (62).*

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* "American Journal of Science," 1876.

† "A Discussion of the Meteorology of the part of the North Atlantic lying North of lat. 30° N. for the Eleven Days ending February 8th, 1870, by Captain Henry Toynbee.

‡ "The Mean Pressure of the Atmosphere and the Prevailing Winds over the Globe for the Months and for the Year." By A. Buchan, M.A., F.R.S.E. "Transactions of the Royal Society," Edinburgh, vol. xxv.

Bermuda seems to be peculiarly placed with regard to the winds of which we are speaking, for the observations given in the first number of the publications by this office, as well as those given by Buchan, together with others sent by General Lefroy, which are quoted in this paper, show that these islands are subject to alternations of Northerly and Southerly winds in winter, whilst in summer scarcely any Northerly wind is recorded.

The fact of this alternation between Northerly and Southerly winds in winter seems to show that the position of this area of low pressure may be variable, and that it may sometimes lie to the Eastward, sometimes to the Westward of the islands. When summer sets in, and an area of low pressure takes the place of the high pressure over the land, the element for a Northerly wind is taken away, so that Bermuda and the American coast are subject to Southerly winds.

It will be readily understood how this alternation of high and low barometer over the land in winter and summer accounts for the extremes of cold and heat experienced by the East Coast of America, whilst we on the Eastern side of the Atlantic are, in accordance with Buys-Ballot's Law, subject to Southerly winds in winter, the highest barometer being then to the Eastward of us.

To return to our subject: If the trough of low pressure cannot be shown to change its position, we have strong proof that frequent collisions take place between the Northerly and Southerly winds which blow in its neighbourhood, causing eddies, and that these eddies pass over Bermuda on a North-Easterly route, producing first a South-Easterly and then a North-Westerly wind. We are thus led to the conclusion that these gales are caused by a collision between opposing currents of air.

The few storms dealt with in this paper support the idea that most of the winter snow-storms of the Coast of America are connected with these gales. Besides the trough of low pressure over the Gulf Stream to which we have alluded, Buchan's charts show a larger area of depression in the neighbourhood of Iceland at this season of the year, which is related to the prevailing winds of winter. It is probable that this low pressure is frequently intensified by the areas of low pressure which travel towards it from the East Coast of America, and that these areas of low pressure, taken in conjunction with the very high pressures which generally exist over the land in winter, are the causes of our winter gales.

2. We will next consider the tracks of these gales. All the evidence gained by studying the data for these 11 days shows that they move to the North-Eastward, and probably at a mean rate of nearly 30 miles an hour.

To give a graphic representation of their progress, the last chart has been constructed; it contains reductions of the whole 14, placed under each other in the order of time. There it will be seen that the gale of the 30th of January was South of Halifax at 8 a.m., had advanced towards Newfoundland by 6 p.m., and was half across the Atlantic by 8 a.m. of the 31st, when it seemed to be lost in the normal area of low pressure over the centre of the Atlantic.

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* The conclusions derived from a study of the data for this region for January will be found in the Report of the Meteorological Committee of the Royal Society for 1871.

A similar gale appeared on the 2nd of February; it advanced to the North-Eastward, and was lost by the 4th. On the 4th, a N.E. gale was blowing on the American coast, and a moderate S.E. wind in 32° N. and 51° W. Unfortunately there was a large space of sea in the South-Western quarter of the chart without ships, so that we have not such clear evidence of the progress of this gale; still on the 5th we find a very heavy gale and remarkable low pressure in the middle of the Atlantic, with a heavy N.E. gale blowing in Iceland and on the American coast, and an equally heavy S.W. gale in about 30° W. There are reductions of three charts for the 5th, viz., at 8 a.m., 3 p.m., and 8 p.m. These show the North-Easterly progress of the area of lowest pressure.

On the charts of the 6th and 7th, the direction of the wind indicates that another area of low pressure was advancing from the South-Westward, which showed itself to the South-Eastward of Newfoundland on the 8th. On this last chart three areas of low pressure are shown, the last just appearing on the South-Western corner of the chart; this the extracts prove to have been very severe, and to have advanced to the North-Eastward, and it again was followed by another area of low pressure.

The point of lowest pressure and complete eddy may be formed just where the counter-currents of air are in close contact, and its apparent motion may be caused by the closing in on each other of these currents of air, by which means the eddy is being constantly re-formed at the new point of contact. The chart of 8 a.m., February 5th, is supposed to illustrate this idea.

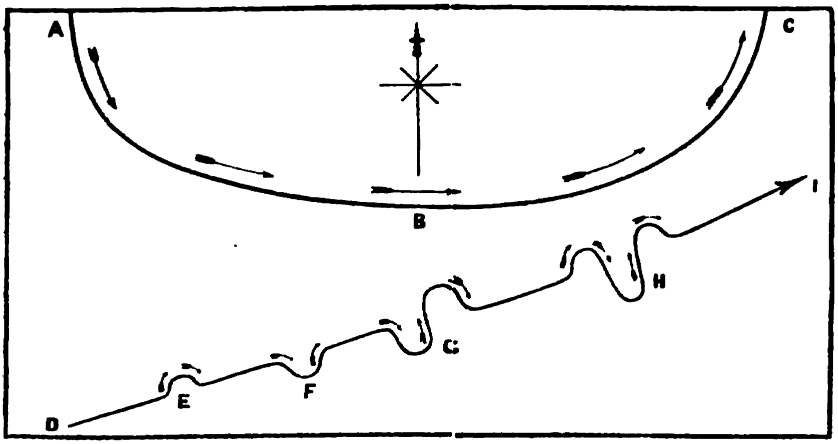
If we consult Buchan's Isobars of Mean Pressure for these months, we find that they trend to the North-Eastward from the Coast of America to England, and that the prevailing wind follows them, drawing rather towards the area of lowest pressure in the neighbourhood of Iceland. Hence, it seems fair to suppose that the tracks of these occasional eddies may be influenced by the main stream of air which seems to be flowing to the North-Eastward round and into the area of lowest pressure, just as an eddy in a river is carried along by the main stream.

The data we have been dealing with prove that the points of *lowest* pressure in these areas of low pressure do not generally cross the British Islands; for instance, at 8 p.m., February 5th, the barometer was down to 27·38 in about 51° N. and 25° W., and at 8 a.m. of the 6th it was 28·22 in about 55° N. and 18° W., with a hurricane blowing from S.S.W. This direction of the wind indicates that there was a lower pressure to the Westward, hence we may conclude that the area of *lowest* pressure took a very Northerly course. Still, its influence was felt at all the self-registering observatories, taking Valentia first, and passing on to Aberdeen.

In the general remarks following the extracts for February 5th, we have pointed out how the gale which Valentia experienced later in the day is pictured on our 8 a.m. chart. The reader will do well to study the remarks published in the Quarterly Weather Report for February 4th to the 7th, as well as its Plate VIII. There it is shown on page 10 how at 8 a.m. of the 5th, "neither the daily chart nor the barograms showed any very serious sign of disturbance." On page 11 there is the following remark: "The facts appear to show that the gale which ensued on our coast was to the full as much to be attributed to the advance of the high pressure Westward from Russia, as to that of the low pressure Eastward from the Atlantic." The isobars on our charts for the 6th, 7th, and 8th, seem to prove the force of this remark.

Whatever may be the cause of these areas of lowest pressure, the five diagrams which follow the charts, as well as a large number of others received from the commanders of steamers to and from America, who are observing for this office, show that very many of them are experienced in the Atlantic, and the difference between the barometer curves of outward and homeward bound steamers, as well as the extracts from logs, show that they are travelling to the North-Eastward.

Normal state of Atmospheric Pressure and Wind between England and North America in Winter.



Undulations of Barometric Pressure moving 30 to 40 miles an hour to the North-Eastward, with their accompanying Winds.

We have, then, two important facts: 1. By consulting Buchan's Isobars, we find that during the winter months the normal state of pressure is high over the land on each side, and low over the sea in the central part of the Atlantic, also that the pressure gets lower as you go North from the Azores. Let the line A B C in the diagram above be supposed to represent a section of the normal state of pressure across the Atlantic, with a lower pressure to the North than to the South of it, then the arrows may be supposed to represent the normal direction of the wind.

2. Besides this normal state, we have, as it were, the crests and hollows of waves of pressure moving to the North-Eastward. These (the diagrams

show) sometimes follow each other very closely, and may be represented by the line D I. Keeping Buys-Ballot's Law (page 113) in mind, let us suppose that a *ridge* of high pressure (E) be experienced travelling to the North-Eastward, we know that it would be accompanied by corresponding winds, viz., Northerly followed by Southerly.

If merely a *Depression* (F), then Southerly winds would precede Northerly.

If a *Ridge and Depression* (G), then Northerly, Southerly, and Northerly, would be the order of the winds.

If a *Ridge and Depression be followed by another Ridge* (H), then Northerly and Southerly changes would be twice experienced.

Now it is hardly possible to look at the diagrams which accompany this paper without perceiving that they give sections of disturbances which could be explained by some one of the above cases. We may also suppose that after they have passed over a ship, the winds will be inclined to take up the normal direction as shown on the line A B C.

If the reader can suppose such changes of pressure as are represented by the line D I to be travelling to the North-Eastward over a sea which has its normal pressure represented by the line A B C, he will get the idea we wish to convey.

In the course of this paper it has frequently been remarked that with a *steamer bound to the Eastward*, the barometer was falling with a Northerly and rising with a Southerly wind. Now it is quite clear that this would *always* be the case with a steamer steering to the Eastward, if the atmospheric pressure over the Atlantic were always in the normal state represented by the line A B C, and this order of rise and fall would be reversed with a steamer bound to the Westward.

Again, suppose it were possible that a steamer could go to the North-Eastward faster than an atmospheric disturbance represented by the depression F, and so cut through it, then it is clear that she would have a *falling* barometer with a Northerly, and a *rising* barometer with a Southerly wind; but if these disturbances move at a speed of 30 miles an hour, it is clear that a steamer could not outstrip them, but only keep longer under their influence when steaming fast to the North-Eastward, than when standing still or going to the Westward. Hence we may conclude that when the barometer falls with a Northerly and rises with a Southerly wind, as a ship steams to the Eastward, she is experiencing, either the normal state of pressure, or a slowly moving disturbance.

We give only two instances of the barometer falling in a Northerly wind, with a ship steaming to the Westward, and they were both in the great gale of February 5th. They seem to indicate that the depression was increasing in intensity faster than the ships could move away from it. Such cases should be considered as important warnings.

The various extracts which follow the 8th of February, when an Easterly wind set in on the North-Eastern part of the chart, and worked its way to the South-Westward, seem to show that such a state of things does not check the formation of cyclonic gales off the Coast of America, for they were still experienced, and, judging from the Bermuda data, the North-Westerly winds were stronger. The routes which the gales took seemed, however, to be more Northerly, as if the Easterly wind interfered with their usual progress to the North-Eastward.

Considering the normal state of the wind, it seems clear that *in so far as the direction of the wind* is concerned, a sailing ship bound from England to America at this season of the year (February), should keep her yards well in, and gain good way, even though she may get driven to the Northward by the South-Westerly winds which prevail on the Eastern side of the Atlantic, for there is good reason to expect that the wind will draw to the Northward of West as she gets over to the Westward. The chances of meeting with ice, and other risks, would of course need careful consideration.

The very little progress (360 miles in a direct line N. ½ E. from lat. 31° 30′ N., long. 72° 30′ W., to lat. 38° N., long. 71° 15′ W.), made during the 11 days by No. 38 (the sailing ship *Nicoline*), bound from Santos to New York, makes it probable that she would have gained by making her northing several degrees farther to the Eastward, where the charts show that a Southerly wind prevailed; instead of closing with the land, where there was an almost constant fresh Northerly wind.

This paper gives sufficient evidence of the caution needed when a S.E. wind sets in with a falling barometer. Captains used to the trade know these gales well.*

It is not necessary to repeat here what has already been said in the Barometer Manual, on the use of the barometer to seamen, and its various action depending on a ship's course and speed.

Mr. Meldrum, the meteorologist of the Mauritius, in pursuing a similar enquiry with regard to the weather in the Southern Indian Ocean, finds that there waves of high and low pressure follow each other on an Easterly course at an average speed of about 20 miles per hour.

It will be remembered that we find these waves to travel at the rate of 30 or 40 miles per hour. When we consider how the Northern part of the North Atlantic is much more surrounded by land than the Southern part of the Indian Ocean, causing more sudden differences of temperature, we may well suppose that the differences of pressure will be greater in the North Atlantic, giving more activity to the changes of weather.

Mr. Meldrum also finds that the Hurricanes of the Southern Indian Ocean take their origin in the district lying between the N.W. Monsoon and S.E. Trade, where the barometer is generally lower than to the Northward and Southward, just as we have already stated that the winter gales which blow to the Eastward of those meridians originate only within this band. On the contrary, it is evident from the Tables that even if that band forms the region where the Polar Current flows most strongly Southwards, yet a quantity of narrower air currents take the same course, and their interstices are filled up by currents of equatorial air of different breadths, which flow more or less quietly side by side in opposite directions until the increasing differences of tension create a necessity for restoring equilibrium.

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* In connection with barometric changes, we may here advert to the constitution of the atmosphere, as mentioned (12) on page 102. To that statement we add the following conclusions arrived at by Professor Dové, of Berlin, from his observations.

In the Northern Hemisphere, the *Barometer* falls during E.S.E. and East winds; passes from falling to rising during S.W. winds; rises with those from W.N.W. and North; and has its maximum rise with a N.E. wind.

The *Thermometer* rises with E.S.E. and South winds; has its maximum with S.W.; falls with W.N.W. and North; and has its minimum with N.E. winds.

The *Elasticity of Vapour* increases with E.S.E. and South winds; has its maximum at S.W.; and diminishes during the wind's progress by West and N.W. to North; at N.E. it has its minimum.

In those regions of atmosphere lying to the Eastward of an equatorial wind (which comes up with a low barometer), an efflux of the air takes place (therefore a rapid fall in the barometer) with winds backing to S.E.; meanwhile the S.W. wind advances, the barometer falls to its lowest point, and the thermometer rises to its highest; but the heavy rain which now falls so lessens the tension of the Southern air, and the difference of pressure becomes so great, that the polar current lying to the Westward rushes in furiously, the wind vane quickly veers to West and N.W., and with rapidly rising barometer equilibrium is restored amid electrical discharges, sleet, and hail squalls.

In all these conditions, which find their outward expression in the change of wind direction, pressure, and temperature, neither the cyclonic theory of the Tropics nor the so-called laws of gyration are wanted, which, if we consider them in the most favourable light, are neither more nor less than expressions for long-established views.

(128.) **British Isles.**—"Weather Charts and Storm Warnings" is the title of a small work written by Mr. Robert H. Scott, M.A., F.R.S., Director of the Meteorological Office in London, as a help and guide to the sailor in using the cone signals, and also to those studying the Weather Charts now so generally inserted in the daily newspapers. In this book, of which a revised edition was published in 1887, will be found all the latest knowledge which has been gained relating to the Winds of the British Isles. Another useful little work, giving much information in a condensed form, is "Weather Forecasting for the British Isles," 1890, by Captain Henry Toynbee, F.R.A.S., &c., from which we have already made several extracts. We give below a short summary of the most interesting facts.

It has been found that nearly all our Storms are of a rotatory nature, and travel from S.W. to N.E., or from the Westward towards the Eastward, as is evidenced by the fact that out of twenty-three Storms felt in Hamburg in the year 1869, twenty-two had previously passed over some portion of the British Isles.

As before stated, when dealing with the Storms of the North Atlantic Ocean (page 183), these Storms are divided into two classes—Cyclonic, in which the wind revolves *against watch-hands* around a centre of *low* barometric pressure, and Anti-Cyclonic, in which case the wind revolves *with watch-hands*, or in the same direction as the hands of a watch, around a central area of *high* barometric pressure. These terms are, however (as before stated on page 185), only relative, having no reference to a high or low level of the barometer, but to that level as compared with pressures in the surrounding regions. At the centre of a Cyclonic area the level *may* be above 30 inches, and it may be below 29·5 inches at the centre of an Anti-Cyclonic system.

Of these two classes, the latter is of rarer occurrence; and whereas the Cyclonic Storms travel with some rapidity, Anti-Cyclonic areas travel much more slowly. It is a remarkable fact worth mentioning, that in some places the Anti-Cyclonic areas are noticed to remain as it were stationary; this is frequently the case at the entrance of the English Channel, especially in early autumn, when they have been known to remain for days together in the same locality. The centres of the Storms generally pass on the Northern side of the British Isles, hence we get more of the S.W., West, and N.W. winds than of those Easterly winds which would be found on the Northern side of the central area of lowest pressure. To this fact we may attribute the prevalence of Westerly winds, shown in the Table, drawn up from observations made at Liverpool. Owing to the smallness of the area covered by the British Isles, it is seldom that a perfect rotatory gale can be traced in its passage, but inferences are drawn from the observations made on small portions of such Storms, at stations in these islands and on the Continent.

The best idea which we can gain, for practical purposes, of the winds which affect us in these islands, is that the air over the Atlantic Ocean, North of latitude 40° N., is constantly flowing from West to East, like a gigantic river. If such a river be flowing rapidly, we often see on its surface small waves, each with its own eddies and circulations, which are carried on with the stream. If we could look at the upper surface of the atmosphere, we should see much the same sort of conditions, except that what corresponds to the hollow of the wave would be a patch of defective pressure, while that which corresponds to the crest of the wave would be an area of excessive pressure.

(129.) The more characteristic Winds of the West of Europe, and especially of our own islands, are due to atmospheric disturbances producing areas of high or low pressure; the rapidity and intensity of the development of which, with the direction of their paths and their position, determine the force of the Wind, the direction in which it blows, and the manner in which it veers or backs, that is, changes its direction. But *how the changes of pressure are determined*, and *what causes the transfer of the disturbed area* (commonly under the form of an atmospheric eddy or vortex, in a definite direction, usually from West to East), is still to be ascertained; though here, too, it is obvious that the distribution of the land and sea areas, and of the ocean currents, on which the temperature of the superincumbent air so immediately depends, combined with the rotatory motion of the earth, are among the principal agencies at work. The winds of our islands have commonly, more or less distinctly, the gyratory character, which is one of the secondary results of the rotation of the earth.[*]

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[*] See "Lectures on Geography," delivered before the University of Cambridge, by General R. Strachey, R.E., F.R.S., published in the Proceedings of the Royal Geographical Society, April, 1888, page 280.

(130.) *Weather.*—Regarding the Weather accompanying Cyclonic Storms which cross the British Isles, the Hon. Ralph Abercromby has carefully studied the Weather Charts issued by our Meteorological Office, and given his conclusions in the work mentioned below,* as follows:—The broad features of the Weather in a *Cyclone* are—a patch of rain near the centre, a ring of cloud surrounding the rain, and blue sky outside the whole system. The precise form and position of these areas vary with the type of pressure distribution, with the intensity (wind force) of the Cyclone, and the rate of its progress; they are also influenced by local, diurnal, and seasonal variations.

The weather and sky over the whole *front* of a Cyclone—*i.e.*, all that lies in front of the trough (118) is characterized by a muggy oppressive feel of the air, and a dirty gloomy sky with clouds of a *stratified* type. The line of the *trough* is often associated with a squall or heavy shower, commonly known as a "clearing shower." The whole of the *rear* of a Cyclone is characterized by a sharp brisk feel of the air, and a hard firm sky with clouds of *cumulus* type, *cirrus* being almost unknown in the rear of a cyclone-centre in the Temperate Zone.

It might obviously be expected that the weather in any part of a large Cyclone, as, for instance, in one of those which completely cross the Atlantic Ocean, would be very different from the weather in a small Cyclone which perhaps only just crossed the British Isles, and this is fully borne out by observation. In very large Cyclones, the steepest gradient, and the bad weather which accompanies them, are always found at some distance from the centre. Round the centre itself, when the gradients are very steep, the sky is broken with hardish clouds, and there is a cold pleasant feeling in the air. In small Cyclones the heaviest rain usually surrounds the centre, and extends more or less to one end or the other, according to the direction of the nearest area of high pressure, and the steepest gradient.

The broad features of the Weather in an *Anti-Cyclone*, are— blue sky, dry cold air, a hot sun, and hazy horizon, with very little wind—in fact, the very antithesis of everything which characterizes a Cyclone. Synoptic charts show great irregularity in the position of cloud, &c.

(131.) Mr. Ley, in his pamphlet already quoted on pp. 183, 184, makes the following remarks, and by comparing these with the accompanying diagram, a clear idea will be obtained of the distribution of Clouds and Weather in a typical *Cyclonic* disturbance.

In the most general way it may be stated that foul weather characterizes the Cyclonic, and fair weather the Anti-Cyclonic systems; and it will at once be seen that to this statement corresponds the old but loose and vague rule that the barometer falls before rain or storm, and rises before fine or calm weather.

In the extreme front of a large depression, there commonly stretches a great bank or sheet of *cirro-stratus* cloud. The movement of the upper current which carries the outlying parts of this elevated cloud-bank is often nearly tangential to the edge of the cloud-bank itself, and nearly opposite to the direction of the wind which is presently about to spring up at the earth's surface, and in nearly all cases it makes a greater angle than 90° with this wind. It is important to observe that when this movement is very rapid, the approaching depression may be expected to be "deep," and probably attended by strong winds at the earth's surface. As the sheet extends over us, the upper current backs very quickly, and continues to do so over the whole front half of the advancing system.

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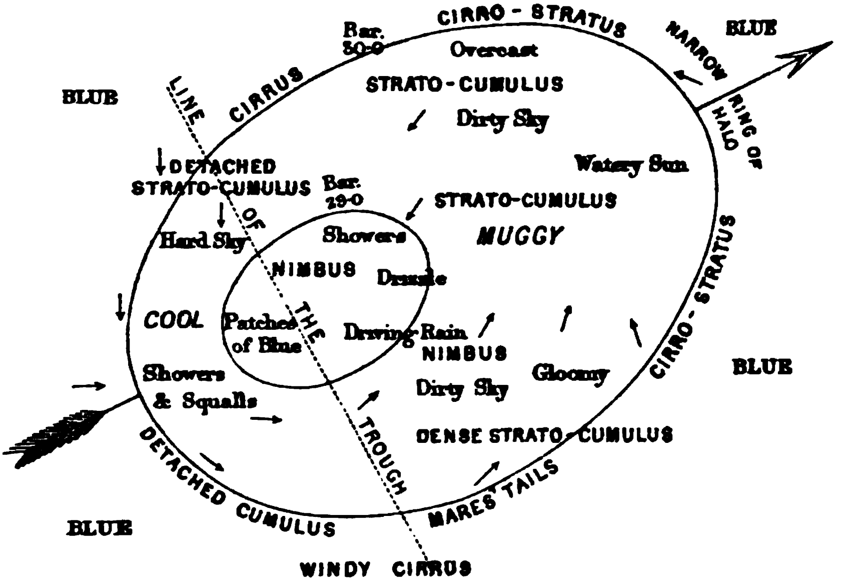
* "Weather, a Popular Exposition of the Nature of Weather Changes from Day to Day," by the Hon. R. Abercromby, F.R.M.S., &c., 1887.



Distribution of Clouds and Weather in a typical Cyclonic Disturbance.

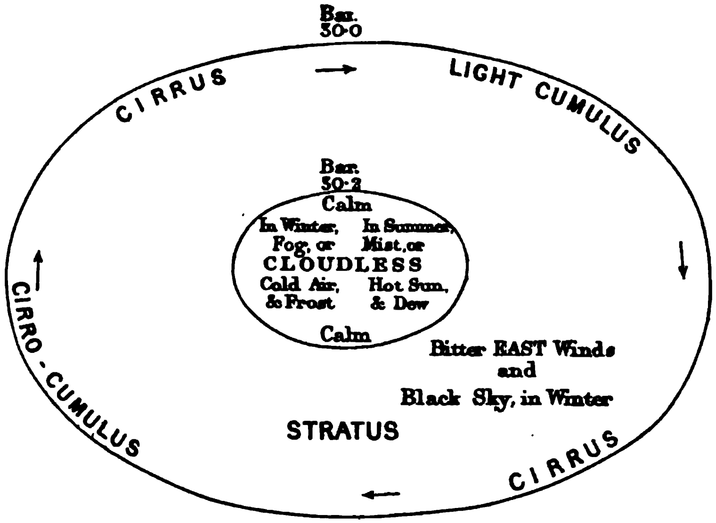
As the centre advances towards us, we commonly observe composite cloud (*nimbus*), the rain or snow being accompanied by the new current of air belonging to the depression. This cloud-bank extends in most instances nearly over the whole front half of the system, both on the right hand and left hand of the centre's path, but its character differs very considerably on the two sides.

If the centre is passing so as to leave our station on its *right*, the *nimbus* usually continues until the centre has almost reached its nearest point to us. Then, usually after a sudden increase of precipitation, the sky clears, the *cirro-stratus* terminating in an abrupt line, while the wind at the earth's surface begins to veer. Up to this time the barometer will have continued to fall, except in those cases in which the whole system is becoming rapidly shallower; and the pressure now begins to rise, except in those instances in which the depression is becoming rapidly deeper.

The appearance of the sky in the *rear* of the disturbance, but still on the *right* hand side of the centre's course, is usually very unlike that in the front. Comparatively few upper clouds are observed, and the movement of these is commonly noticed to be nearly the same with that of the current on the earth's surface. In lieu of *cirro-stratus* we see *fleecy cumulus*. Shower-clouds are also common over this district. The atmosphere in this part of the disturbance is in most cases clearer or more devoid of haze than in the front, and temperature is also commonly lower; but marked exceptions occur to both these rules. A rapid and excessive decrease of temperature is not uncommon when the wind has begun to veer, particularly near the centre of the Cyclonic circulation.

Let the reader now turn his attention to the other side of the centre's path, and let him suppose the barometric minimum in its onward progress to leave his station on the *left* of its course. Here the *nimbus* extends over us, the wind after springing up commences to back, and continues to do so throughout the passage of the disturbance. On this side we very rarely experience the abrupt change from a rainy to a clear sky which is so usual on the right hand side. As the centre passes, the higher cloud forms gradually degenerate into banks of dreary *stratus*, often attended with an increase rather than any diminution of haze. As the rear of the system approaches us on this side the bolder forms of *cumulus* are rarely seen, and in place of the shower-clouds we commonly notice gloomy-looking banks of condensed vapour in the middle and lower levels of the atmosphere, while *cirrus* has usually almost or altogether disappeared.

In the actual *centre* of a large depression the sky is often comparatively clear. Shower-clouds are frequently visible, but these have usually here a thin soft and disintegrated aspect, while *cumulus* tends to spread itself into *stratus*, and *cirrus* lies in broken, though watery-looking patches.



Distribution of Clouds and Weather in an Anti-Cyclonic Area.

(132.) The above diagram shows the general distribution of clouds and weather in a typical Anti-Cyclone, but the weather which characterizes

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ASTOR, LENOX AND
TILDEN FOUNDATIONS.

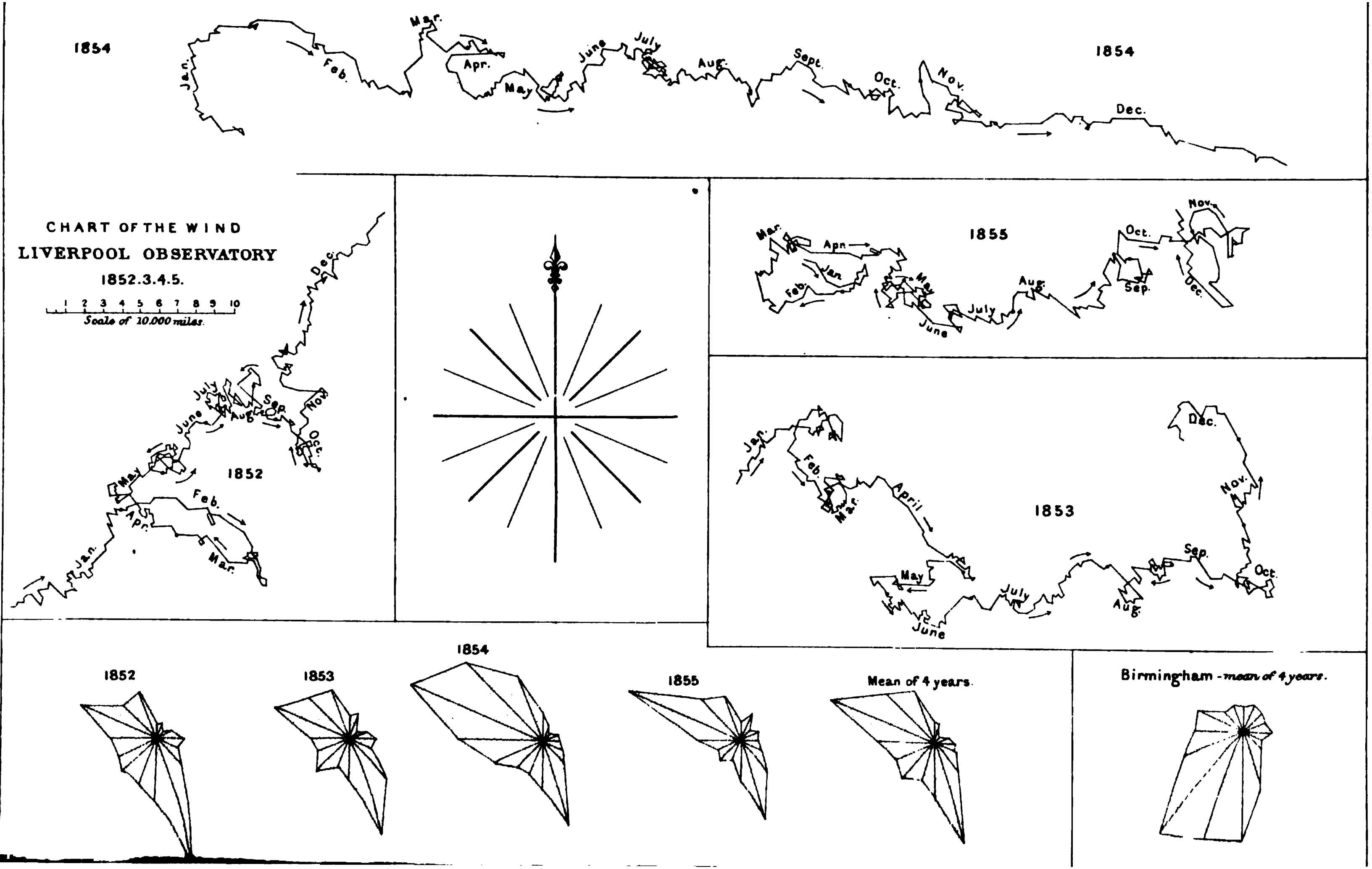

CHART OF THE WIND
LIVERPOOL OBSERVATORY
1852.3.4.5.

R. H. Laurie, 35, Minories, London.

our Anti-Cyclones is subject to modification according to the seasons. In summer, brilliant weather usually accompanies them, and in the central districts particularly the sky is often nearly or totally devoid of cloud; at other times light fleecy *cirrus*, whose motion is extremely slow, is the principal cloud visible. In winter, dry weather *stratus* is the most common form of cloud, occasionally covering nearly the whole of the Anti-Cyclonic system with an unbroken canopy.

(133.) From statistics, recently prepared at the Meteorological Office, of Gales and Storms occurring in the British Isles during the fifteen years 1870—1885, it appears that the most stormy area is at the entrance of the English Channel. Agreeing with the experience of the North German Lloyd steamers, as described on page 196, the summer is shown to be nearly free from Storms, they being almost exclusively confined to the winter half-year, the latter half of January being the stormiest period of all. Contrary to the general idea, there is no marked stormy period at either Equinox, though the frequency increases after the autumnal Equinox, and decreases from January towards the vernal.

(134.) **Greenwich.**—The following Table gives the Mean Annual Number of Days of Prevalence of the Different Winds during the forty-nine years from 1841 to 1889, from the Records of the self-registering Osler Anemometer at Greenwich Observatory.*

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
Mean 1841—1864	39	46	23	21	32	107	41	24	32
„ 1865—1889	40	44	31	23	37	106	50	21	13
„ 1841—1889	40	45	27	22	35	106	46	22	22

(135.) **Liverpool.**—At the former Liverpool Observatory, near the Waterloo Dock, an Anemometer, the invention of Mr. A. Follett Osler, F.R.S., registered the force, or rather the motion and direction of the air, for the years 1852—1855. The lines thus drawn by the machine itself are reduced on the adjoining diagram, and represent the actual direction and distance, according to scale, travelled by the wind over the instrument. Upon looking at these lines, except the general tendency to the Eastward, there is no similarity between the years; yet, by taking the absolute motion throughout the year of the wind from any quarter, and forming a single diagram, there is seen to be a remarkable identity in them all.

Thus, the main direction of the wind in 1854 was rather to the Southward of *West;* in 1852, it was to N.W.; and in the other two years, although to the West, yet the wind was very devious.

Notwithstanding the wide difference in the lines formed in these different years, yet if the whole amount of wind in each year is arranged graphically for each point of the compass, they are very similar to each other, showing that a fixed law prevails; which is still more evident if the duration of their prevalence were taken instead of their quantity or velocity. This is shown by the wind-stars on the diagram.

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* On the Relative Prevalence of Different Winds at the Royal Observatory, Greenwich, 1841—1889, by William Ellis, F.R.A.S., published in the Quarterly Journal of the Royal Meteorological Society, 1890, pp. 221—224.

(136.) The total amount of the *Horizontal Motion* of the air at Liverpool, as registered by the Anemometer, is also exceedingly alike in different years, as shown by these figures:—

	Wind in Miles.	Calms.	Rain.	
			Quantity.	Duration.
1852	114,276	19 hours.	31·59 inches.	683 hours.
1853	105,989	27 „	22·47 „	625 „
1854	128,283	4 „	22·11 „	537 „
1855	103,405	12 „	22·57 „	510 „
Mean	112,989	15·5 hours.	24·67 inches.	597 hours or 24 days 21 hours.

The *Seasons* have an influence on the velocity of the wind; thus, these observations show that in *Winter* (December to February), the mean rate is 15·6 miles per hour; *Spring* (March to May), 12·1 miles per hour; *Summer* (June to August), 11·8 miles per hour; and *Autumn* (September to November), 11·5 miles per hour. In the day, winds are stronger than at night; thus, at midnight, it travels 11·2 miles per hour; 6 a.m., 11·8 miles per hour; 9 a.m., 12·9 miles per hour; noon, 13·2 miles per hour; 3 p.m., 14·6 miles per hour; 6 p.m., 12·7 miles per hour; and 9 p.m., 11·6 miles per hour.

Direction.	Miles per hour.
N.	7·8
N.N.E.	6·2
N.E.	6·6
E.N.E.	7·8
E.	11.0
E.S.E.	9·6
S.E.	11-6
S.S.E.	11·4
S.	10:3
S.S.W.	11·8
S.W.	16·7
W.S.W.	15·5
W.	18·9
W.N.W.	19·0
N.W.	17·4
N.N.W.	12·7

But the more important general deduction to be derived from these observations is the fact, as before alluded to (135), that all winds having a *Westerly* bearing travel very much the fastest; those from South to East proceed at a much slower rate; while such as come from the North and East average but little more than a third of the rate of the Westerly winds. All this is made clear by a glance at the column of figures in the annexed Table, which gives the Mean Rate in Miles per Hour of the winds from the various directions; and will show further that the wind-roses and figures of Maury's and other charts do not give an accurate knowledge of this zone of winds, as the Westerly winds, though by them made greatly to predominate, do not show the *actual amount* of those winds by, perhaps, one-half or two-thirds of their real quantity. All the strongest gales recorded in those years came from Western quarters.

(137.) In continuation of the above observations, the Anemometer records show the *mean* annual duration of winds from the various quarters, for the twelve years 1852—1863 inclusive, to be as arranged in the following

Table, in which we also give the maximum and minimum number of days occurring during that period.

Quadrant.	Mean Number of Days.	Maximum Number of Days.	Minimum Number of Days.
1st. Winds between N. & E.	51·4	75·0 in 1855	24·7 in 1863
2nd. „ „ E. & S.	116·0	134·1 in 1861	93·9 in 1854
3rd. „ „ S. & W.	84·5	125·0 in 1863	59·9 in 1855
4th. „ „ W. & N.	112·6	138·0 in 1854	92·8 in 1852

The mean duration of *Calm* for the twelve years was 0·8 day per annum, varying between 0·2 day in 1857 and 1·6 day in 1858.

(138.) Notwithstanding that the results shown by the Liverpool Anemometer are of the utmost value, and great labour and skill were exercised in reducing them to a comprehensive form by the late Messrs. John Hartnup, father and son, the able superintendents, yet they contain evidence of the interference of land influences, as alluded to in (104), page 171. The self-recording anemometer showed that the winds from W.N.W. and S.S.E. were most prevalent, whereas the prevalent direction in England as a whole is from the West; showing that the form of the valley of the Mersey has much to do with diverting the normal direction of the wind. Still the observations, as before stated, are most instructive and important.*

(139.) About the year 1865, the site of the Observatory at the Docks being wanted for other purposes, the instruments were removed to a new Observatory on Bidston Hill, on the opposite side of the Mersey, at an elevation of about 190 ft. above sea level. The increased elevation, and more open character of the situation, doubtless give the records of the Anemometer more reliability. We are indebted to the courtesy of the Astronomer to the Mersey Docks and Harbour Board for copies of the Reports issued from the Bidston Observatory, from which a similar Table of the Winds recorded by the Anemometer has been drawn up. They extend over a period of 20 years, from 1868—1887, and show a large preponderance of winds in the S.W. quadrant over the previous records at the Docks.

Quadrant.	Mean Number of Days.	Maximum Number of Days.	Minimum Number of Days.
1st. Winds between N. & E.	55·0	74·4 in 1875	39·4 in 1874
2nd. „ „ E. & S.	102·2	119·8 in 1872	85·7 in 1887
3rd. „ „ S. & W.	114·7	138·1 in 1882	100·1 in 1870
4th. „ „ W. & N.	93·0	114·5 in 1869	77·8 in 1882

The mean duration of *Calm* for the 20 years was 0·3 day per annum, varying from 0·1 to 0·7 day per annum.

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* Report of the British Association, vol. xxv., pages 127—142; and, also, "Report of the Direction and Strength of the Wind at the Liverpool Observatory, 1852—1863." It is from these sources that the above facts and figures are derived.

For the 22 years from 1867 to 1888, the average annual *Rainfall* was 29·235 inches, varying from 23·700 in 1873 to 45·664 in 1872.

(140.) There is one remark respecting *land* observations, which is important:—"All the synoptic charts hitherto advanced at the Board of Trade exhibit a marked *diminution of force* on land compared with that on the sea coast. Indeed, the coast itself offers similar evidence in its stunted, sloping trees and comparative barrenness."* The trees in many localities form excellent wind-vanes, as, by their growth, they show exactly the direction from whence the most powerful and persistent winds come.

It would seem, also, that the land has a tendency to draw the wind towards it, so as in some measure to make it appear that the prevalent direction is more across the line of direction of that coast than is really the case. Looking at the simultaneous observations now daily collected and published for a great extent of coast, this is very apparent. All these arguments tend to lessen the value, in some degree, of those extended and accurate records of the wind on land. The mean direction of the wind, derived from land observations, however, as given by Kämtz and Dové, is as follows:—

England	S. 65° W.	Denmark	S. 62° W.
France and Holland	S. 88° W.	Sweden	S. 77° W.
Germany	S. 76° W.	N. part of United States	S. 86° W.

(141.) **English Channel.**—The following are the results of fifteen consecutive years observations upon the wind, taken by M. Nell de Bréauté, at the Chapelle, near Dieppe, at an elevation of 490 feet above the sea:—

Direction of the Wind.	Mean Number of Days.	Maximum.	Minimum.
South.	37	In 1828— 54 days.	1820 and 1825—28 days.
S.W.	93	1823—121 "	1831—67 "
West.	48	1830— 72 "	1829—31 "
N.W.	52	1825— 72 "	1832—38 "
North.	36	1819— 56 "	1821—21 "
N.E.	41	1826— 54 "	1828—22 "
East.	23	1820— 41 "	1821—12 "
S.E.	31	1818— 46 "	1827—19 "
	Total, 361 days.		

From this Table the following conclusions may be drawn;—

In the 365 days of the year there are about 361 of wind, and 4 or 5 of dead calm.

If the horizon be divided into four equal parts, there will be—

185 days with the wind between South and West,†
94 " " between West and North,
71 " " between North and East,
61 " " between East and South.

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* Third Number, Meteorological Papers, by Admiral FitzRoy, 1858, page 99.

† Upon comparing this direction of West to South with the Liverpool observations, as given in the diagrams, page 203, the disturbing action of the land will be evident.

The maximum of winds between S. and W. takes place in November and Dec.
The minimum ,, ,, May and June.
The maximum of winds between W. and N. takes place in July and August.
The minimum ,, ,, October and December
The maximum of winds between N. and E. takes place in May and June.
The minimum ,, ,, October and November.
The maximum of winds between E. and S. takes place in December & January.
The minimum ,, ,, June and July.

Moderate winds from North and N.E. are those which bring fine weather. In summer the N.E. wind blows more particularly in the afternoon; in the morning the wind is S.E., a slight breeze, and towards noon it changes quickly to N.E.; then it freshens, and towards the evening it sinks; at night it is calm, and the coolness condenses the vapours. When this condensation does not take place, it is a sign of a change of wind.

Dead calms are of rare occurrence, and do not last long, except during summer. When they occur in winter, it is regarded as a precursor of bad weather. It is always, in reality, an indication of a change in the direction of the wind.

Some further remarks on the Winds, &c., of the English Channel, will be found in the Sailing Directions accompanying the Chart of the English Channel, by A. G. Findlay, F.R.G.S.

(142.) The remarks made in the foregoing pages will be ample for the purpose of giving the sailor an idea of the relative Duration, Force, and Direction of the Wind in the Northern part of the North Atlantic Ocean. Reverting to the observation made on page 203, it may be re-stated, that notwithstanding the variable nature of its changes, and the great difference that is found to occur between one period and another, yet, when these are combined in a long series of observations, there is great similarity; and this will be accounted for in a measure by the researches of our own and the United States Meteorological Offices, which have shown that there is a systematic progress of air from the Westward to the Eastward in our latitudes (see pp. 181—198 and pp. 198—199). For the service of the mariner, in foretelling what weather is approaching, he is referred to Section 2, on the Motions and Pressure of the Atmosphere, and for further information he can consult the "Barometer Manual for the use of Seamen", or "Instructions in the use of Meteorological Instruments," issued by the Meteorological Office, and to "Weather Charts and Storm Warnings," by Robert H. Scott, M.A., F.R.S., &c.

The diagrams adjoining page 171 have been drawn up from Maury's Pilot Charts in the same manner as those given at page 135, to illustrate the Trade Winds. They are selected from those parts of the ocean most generally traversed by ships crossing it in the strength of these Westerly winds. Their localities are shown by the latitude and longitude assigned to each diagram, which thus represents the wind in the region for 150 miles around that position. But, as will be seen at a glance, there is a great similarity in the general features of them all.

The principle upon which these Wind-roses are constructed is explained on page 133 (57); and the six examples there given are analyzed in page 134. The remark in the note (*) should be particularly attended to in connection with the observations in these Anti-Trade winds, as it is clearly futile to endeavour to lay down any *refined* rule for their practical application. As there certainly is a doubt as to the accuracy of the recorded direction of the wind to the extent of two points—to lay down rules for sailing over any area with a course limited to a few degrees, certainly appears to be a needless refinement with the present data to argue upon, but in future years extended knowledge may make it possible to lay down such rules.

(143.) In comparing the observations, recorded by Mr. Osler's self-registering wind-guage at Liverpool, as shown in page 204, with the second diagram adjoining page 171—that for lat. 52° N., and long. 15° W.—or off the West Coast of Ireland, where we might expect to find some degree of similarity, there appears to be scarcely any accordance at first sight. But upon referring to the evidence of the greater force of the *Westerly* winds over the Easterly, as shown by the figures (136), page 204, we arrive at a reason why this apparent discrepancy exists. If the arrows on the West (or windward) side of these diagrams were enlarged in proportion to the relative force, and the Easterly arrows diminished in like manner, there would be a much nearer approximation. This comparison will demonstrate how the direction of the valley of the Mersey, and the line of docks and walls at Liverpool around the observatory, diverted the true direction of the winds. For the purpose of still further exemplifying this, the mean of the observations recorded at Birmingham for four years, by another anemometer of Mr. Osler's, is given. Although this is inland, and necessarily subject to land influences, the Westerly preponderance is clearly marked, and serves to bear out the modern discovery of the progress of Cyclonic disturbances across the British Isles from West to East, their centres generally passing North of our islands.

The diagrams, as we give them, or the figures in Maury's chart, must be studied, should any greater exactness in the relative duration of any wind be required than can be acquired at a cursory glance; and in the former case, as was before explained, the length of the arrow applied to the scale at the bottom of the plate will give the exact ratio *per cent.* of the wind represented by that arrow.

One general remark only need be given; it is, that the greatest irregularity in the direction of the wind in these latitudes appears to occur about the Azores; during the summer months the wind is frequently from Northern quarters, driving before it the colder water from the polar regions, and thus abnormally reducing the temperature. Besides this, there appears to be a conflict between this Southern and Western tendency, and the Trade Wind which is established to the West of them.

(144.) **Bay of Biscay.**—The winds in the Northern part of the Bay of Biscay do not differ greatly from those experienced in the entrance of the English Channel. As we approach the head of the bight, however, it is necessary to use great caution, and observe all indications of the change of the wind.

The prevailing winds in the Bay of Biscay are those from N.W., West, and S.W., with frequent severe gales from those quarters, accompanied by rain, hail, and thick weather, and a mountainous sea. A low barometer, a Westerly swell, and other threatening appearances, indicate the approach of one of these gales. Very often it commences at South or S.W., with rain and thick weather, and then gradually veers round to West and N.W., with clearer weather, and may then, after a day or two, back to the S.W. and blow for several days from that direction.

Easterly winds occur at intervals, being most common about the Equinoxes, especially in spring. In June, July, and August, fine weather prevails, with light Southerly and S.E. winds, though gales may occur from East or West. In October and November dense fogs prevail, but seldom last more than 24 hours.

Northerly winds prevail and are strongest on the parallel of the Pertuis; thence they decrease in frequency and force in approaching the Pyrenees, and the same in nearing the English Channel.

The greatest number of days of North-Easterly winds is about on the parallel of the Island of Groix, and on the island itself these winds are much more frequent than those from the S.E. The days of N.E. wind decrease as the Pyrenees are approached. The East winds blow equally throughout.

The number of days of S.E. wind is greatest at Brest, and least at the Island of Aix; and the number of days of South wind increases as the Spanish coast is approached; at Biarritz it is three times as great as at Brest.

The number of days of S.W. wind is about the same throughout (60 days a year), with a slight increase at Brest, and this wind always brings bad weather. N.W. winds are most frequent at Brest and least so at Biarritz.

The localities most affected by the different winds depend somewhat on the contour of the coast; thus, the heaviest S.W. gales are experienced between Brest and the mouth of the Loire; the heaviest Westerly gales abreast Pertuis and the Gironde district; and the heaviest W.N.W. gales in the lower portion of the bay.

In summer, the reigning winds on the coast at the head or S.E. angle of the bay, are those from N.E. and East, which become North and N.N.W. in the Gulf of Bilbao. These alternate with N.W. and West winds, which generally drop at night, during which they are replaced by the land breeze.

In autumn, Southerly winds prevail, and are usually very violent. They last for two or three days, and sometimes for eight or nine days, the weather being clear; but as soon as they shift to S.S.W., the sky becomes covered with heavy clouds, and almost immediately the "*Vendavale*" or dirty weather from S.W. and West comes on. This, after some days' duration, passes to N.W., with heavy rains and a stronger sea. This wind, much dreaded by seamen, from the heavy surf which it sends in, and because it debars entrance to the few harbours on the Biscayan coast, is very lasting. It is not uncommon to find it continue for fifteen days consecutively, with only two or three days of even moderate weather. But with this N.W. wind there is no fear of being drifted on to the coast, as it is never entirely hidden, and there are sufficiently clear intervals to allow you to make out the land.

It is not so with North and N.N.E. winds; they blow perpendicularly on to the coast, and will not allow ships embayed to clear off shore. They completely hide the land, and are accompanied by much rain and hail, which follow each other almost without interruption. They generally last but a short time, and occur between the middle of December and the end of February, or the beginning of March.

The N.E. wind is not frequent in winter, but it is accompanied by thick fogs, in which case it blows heavily for two or three days, and is then called *Nord-Este Pardo* (the dirty North-Easter). When it shifts to the S.E., by the East, you should as far as possible keep in with the coast, because the wind will shortly come from South. When the South wind, after lasting two or three days, veers to S.W., either get off the land or else enter some harbour, because the N.W. wind will soon come on.

In the spring the winds are generally very light, and nearly always from N.W. or S.W., accompanied by rain. In some years these winds last until July.

The ocean-swell from the N.W., coming from the open Atlantic, is the heaviest and most dangerous on this coast; it penetrates every harbour and creek, and there is no shelter from the waves in any of them until the bars at the entrances become uncovered by the ebb tide. This dangerous state of the sea commences in the middle of September or beginning of October, and, with slight interruption, it continues through two-thirds of the year. This swell is almost always a precursor of the wind from that direction, and sometimes precedes it by twenty-four hours. Sometimes in the summer season enormous waves are seen to set in during perfectly calm and serene weather. They close every harbour, and dash on the coast like enormous mountains of water, and break on the outlying banks with 20 to 40 fathoms water over them. It is needless to state that these are most dangerous to a ship close in with the shore. Captain FitzRoy states that they overtopped the mainyard of the *Thetis*, 56 feet above the water-line.

In August there is a danger of encountering a peculiar squall or tornado, called on the Biscayan coast *Galerna*. It is formed on the land by the sun's heat, and shifts by the S.W.; the horizon becomes obscured, and it quickly increases in strength as it passes to N.W. Every precaution should be taken against them; they are excessively violent, and last three or four hours. They bring rain, and sink at night in the N.W. Sometimes, especially in summer, the *Galerna* is a sudden shift from South to N.W. without any notice, and in this case is very dangerous. It is also common to see winds blowing at the same time from South and N.W., only separated by a narrow belt of calm between the heavy waves they send up.

The South wind is foretold by the atmosphere being so clear that the distant lands and inland peaks become very distinct, and apparently close-to. If the high lands are very clear and distinct, with the wind from East, and a line of ashy-coloured clouds should be seen on the peaks, the South wind is coming on. The local sailors also can foretell the approach by the clouds of dust raised inland, or by the direction of the smoke from the dwellings on shore.

"Why should the sea be higher, or more dangerous, in the Bay of Biscay than it is in the middle of the Atlantic or elsewhere? Is it really so? are questions often asked.

"I believe that there is a shorter, higher, and consequently worse sea, in and near the Bay of Biscay, than is often found in other places, and attribute it to the effect of immense Atlantic waves rolling into a deep bight, where they close upon each other, and receive vibratory undulations from each shore; augmented, perhaps, by the peculiar formation of the bottom of that bay, the variation in depth, and the effects of currents, which, when running over uneven ground, or against the wind, alone cause a heavy swell—a striking exemplification of which may be seen on the Bank of Agulhas, near the Cape of Good Hope."—*Captain FitzRoy*, vol. ii., page 45.

(145.) **North Coast of Spain.**—About Santander the prevalent winds in winter are between South and N.W., by the West. With Southerly winds the atmosphere remains clear for a few days, but they are then considered to be the precursors of N.W. winds. They commence in October and cease in February. When South winds bring clouds and rain they shift soon to S.W., and then rapidly to West, always accompanied by fogs, and terminate at N.W., blowing violently, and raising a heavy sea with strong gusts. When they are at N.W. there are clear intervals which allow the sailor to make out his position on the coast.

The heaviest gales generally commence at South very violent, and they are the more strong according as the sky is clearest. When it is overcast you may look for it from N.W. with squalls.

If the N.W. wind should shift suddenly to North and N.N.E. it becomes very dangerous, because it will not allow vessels to find shelter, on account of the rapidity with which it closes all the harbours.

If after two or three days of Northerly wind it returns to West, by the N.W., it will increase in that direction; but if it shifts to the N.E. the weather will be more quiet, and there may be some days of fine weather. When, after a continuation of N.E. winds, it should shift to S.E., by the East, you may expect Southerly winds soon, and with them bad weather again. In autumn there is a continuation of fine weather, especially after the bad weather which usually accompanies the Equinoxes.

The spring is almost always a continuation of the winter, during which the Westerly winds prevail; they are not so strong, but the accompanying rains are more abundant.

In summer, which generally begins in July, the prevalent wind is from N.E. Close in with the land they haul to seaward, while the sun is above the horizon, and to the land during the night.

The barometer rises with winds from West to N.E., by the North, and falls with all other winds.

(146.) Near Cape Peñas contrary winds are often met with, East or N.E. winds in the offing becoming West or S.W. near the cape, or *vice versa*. In summer the prevalent winds are Easterly, and in winter between S.W. and West, the latter bringing dirty weather. Northerly gales occur between December and March, and are known as *Travesias*.

At Ferrol the prevalent winds are N.E. in summer, and S.W. in winter, the latter bringing bad weather even in summer.

(147.) *West Coast of Spain and Portugal.*—Captain J. McKirdy says:—"I have usually found the winds off Spain and Portugal either up or down the coast, and have heard them spoken of as the 'Portuguese Trades.'

Crossing the Bay of Biscay with a North-Westerly breeze, it is almost sure to lead down the coast, and coming from the Southward with a S.E. or S.W. wind it will lead up. I have seen it once, in the summer time, blowing right on shore, but it was only a moderate breeze, and the weather was beautiful. I have noticed that if the weather is changing from fine to bad, the sky remains clear long after the barometer has begun to go down; say with a S.W. or S.E. breeze coming on, the glass indicates an approaching disturbance, the wind pipes up and the sea rises, then small clouds begin to fly, getting bigger every minute until rain falls, and the sky gets quickly overcast, with heavy rain at intervals. When it is going to fly to the N.W., a harder squall and a heavier shower seem to usher in the change. The barometer springs up a little, then stops, and, as the squall moderates, a thin patch is seen to the N.W., which quickly develops, and soon the sky is cleared, possibly to become partially overcast again. Now the barometer is rising briskly, and the sea goes down as quickly as it rose; two or three hours will raise or allay a good heavy squall.

"There appears to be a perpetual swell coming from the Westward, summer or winter, sunshine or storm. Any time I have passed up or down this coast it has been here, sometimes long and low; at other times high and hollow, but always perceptible, and often a nuisance; for, running down with a North wind and accompanying sea, the two meeting make a ship very uncomfortable.

" Generally speaking, I notice that from whatever quarter the wind may come, the sky keeps clear as long as the breeze is light to moderate in force, but if it freshens it becomes overcast at once; blowing fresh from S.W. to N.W., I may get a blink of the sun for sights, but a strong breeze away by N.E. round to the Southward means a grey coating of clouds all over the sky."—*Nautical Magazine, November*, 1880, pp. 917—918.

We have no trustworthy observations on the prevailing winds on the Coast of Portugal, as affected by local circumstances.

(148.) **Cadiz.**—The sea breezes here vary from West to N.N.W., and are generally strongest at the full and change of the moon, when they not unfrequently blow during the whole night. They set in most commonly with the flood, and are of less strength when the tide makes near noon; indeed, at that period calms are not uncommon throughout the day. The land wind seldom reaches the anchorage, although above Puntales Castle there is scarcely a night without it.

The S.E. and East winds are most dreaded by the inhabitants, but they are by no means so destructive in their effects as the S.W. and Westerly gales, which send a heavy sea into the bay; whereas the East being an off-shore wind seldom creates any swell of consequence. These winds most commonly set in at the full and change of the moon, particularly the former, and blow with great violence; they are seldom known in the winter months, and generally commence in May or June, with intervals of a fortnight or three weeks, and their average duration is three days, but at times five.

The inhabitants consider that when the hills of Ronda appear near and distinct, it is a sign of an Easterly wind, but there are exceptions to this rule. It may, however, be considered almost to a certainty, that when the hills have the above appearance, an Easterly wind exists in the Strait of

Gibraltar. Whenever there is southing in the wind, the atmosphere is always hazy; and if to the Westward of South a dampness ensues, but if to the Eastward of South it becomes hot and dry.

(149.) **Strait of Gibraltar.**—It may be said that two winds only prevail constantly in the Strait of Gibraltar. They are those from East and West, being called by local seamen *Levante* and *Ponente*. These winds are, generally speaking, the results of those from N.E. and S.E., as well as from N.W. and S.W., that are blowing outside the two ends of the strait, and which, on reaching the narrows of the strait, become East and West. Nevertheless, strong South-Easters do not fail to blow in the strait, producing serious damage in the Bay of Algeciras, particularly in winter; as well as South-Westers quite as severe, and commonly called *Vendavales*, According to observations made at Gibraltar, it appears that Easterly winds prevail during July, August, September, March, and December; and that in the other months East and West winds prevail alternately, but mostly the latter.*

(150.) **America.**—When navigating the *East Coast of Newfoundland*, seamen should be on their guard against an indraught among the Fogo and Wadham Islands into Sir Charles Hamilton Sound, Bonavista, Trinity, and Conception Bays; with Easterly and N.E. winds, this indraught is very strong, and these winds are accompanied by thick weather.—H.M.S. *Tenedos*, 1885.

THE GULF AND RIVER OF ST. LAWRENCE.—Rear-Admiral Bayfield states that, during the navigable season, the prevailing winds are either directly up or directly down the estuary of the St. Lawrence, following the course of the chains of high lands on either side of the great valley of the river. Thus, a S.E. wind in the gulf becomes E.S.E. between Anticosti and the South coast, E.N.E. above Point de Monts, and N.E. above Green Island. The Westerly winds do not appear to be so much guided in direction by the high lands, excepting along the South coast, where a W.S.W. wind at the Isle Bic has been seen to become West, W.N.W., and N.W., on running down along the high and curved South coast, until it became a N.N.W. wind at Cape Gaspé. These winds frequently blow strong for three or four days in succession; the Westerly winds being almost always accompanied with fine, dry, clear, and sunny weather; the Easterly winds as frequently with the contrary, cold, wet, and foggy. In the spring, the Easterly winds prevail most, frequently blowing for several weeks in succession. As the summer advances, the Westerly winds become more frequent, and the S.W. wind may be said to be the prevailing wind in summer, in all parts of the river and gulf. Light South winds take place occasionally; but North winds are not common in summer, although they sometimes occur. Steady North winds do not blow frequently before September, excepting for a few hours at a time, when they generally succeed Easterly winds which have died away to a calm, forming the commencement of strong winds, and usually veering to the S.W. The N.W. wind is dry, with bright clear sky, flying clouds, and showers.

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* Further information on the Winds, &c., of the Strait of Gibraltar, will be found in the Sailing Directions accompanying the Charts of "The Coasts of Western Europe" and "The Western part of the Mediterranean Sea," by A. G. Findlay, F.R.G.S., published by R. H. Laurie.

After the autumnal Equinox, winds to the Northward of West become more common, and are then often strong steady winds of considerable duration. In the months of October and November, the N.W. wind frequently blows with great violence, in heavy squalls, with passing showers of hail and snow, and attended with sharp frost.

Thunder-storms are not uncommon in July and August; they seldom last above an hour or two, but the wind proceeding from them is, in general, violent and sudden, particularly when near the mountainous part of the coast; sail should be fully and quickly reduced on their approach.

Strong winds seldom veer from one quarter of the compass to another directly or nearly contrary; in general they die away by degrees to a calm, and are succeeded by a wind in the opposite direction. It is not here meant that they may not veer to the amount of several points. N.W. winds seldom veer round by North and N.E. to East and S.E.; but they do frequently, by degrees, to the S.W., after becoming moderate. S.W. winds seldom veer by the N.W. and North to the Eastward, but sometimes by the South to S.E. and East. Easterly winds generally decrease to a calm, succeeded by a wind from the opposite direction.

In the fine weather Westerly winds of summer, a fresh top-gallant breeze will often decrease to a light breeze or calm at night, and spring up again from the same quarter on the following morning; under these circumstances only, may a land-breeze off the North coast be looked for. The same has been observed off the South coast also, but not so decidedly, nor extending so far off shore. Admiral Bayfield adds, I have occasionally carried the North land-wind nearly over to the South coast just before daylight; but have never observed the South land-wind extend more than 5 or 6 miles off, and that very rarely. Under the same circumstances, that is, with a fine weather Westerly wind going down with the sun, a S.W. land-breeze will frequently be found blowing off the North coast of Anticosti at night and during the early part of the morning. If, however, the weather be not settled fair, and the wind does not fall with the sun, it will usually prove worse than useless to run a vessel close inshore at night in the hope of a breeze off the land.

Such is the usual course of the winds in common seasons, in which a very heavy gale of wind will probably not be experienced from May to October, although close-reefed topsail breezes are usually common enough. Occasionally, however, there are years, the character of which is decidedly stormy. Gales of wind, of considerable strength, then follow each other in quick succession, and from opposite quarters.

Among the difficulties of the navigation in the Gulf of St. Lawrence are the *Fogs* and *Ice*. In spring, the entrance and Eastern parts are frequently covered with Ice, and vessels are sometimes beset for many days. Being unfitted for contending with this danger, they often suffer from it, and are occasionally lost. But all danger from Ice is far less than that which arises from the prevalence of Fogs: these may occur at any time during the open or navigable season, but are most frequent in the early part of summer, They are rare, and never of long continuance, during Westerly winds, but seldom fail to accompany an Easterly wind of any strength or duration. This observation is, however, subject to restriction, according to locality or season. Thus winds between South and West, which are usually clear weather winds above Anticosti, are frequently accompanied with Fog in the Eastern parts of the gulf. Winds between South and East are almost always accompanied with rain and Fog in every part. E.N.E. winds above Cape de Monts, at the mouth of the river, are often E.S.E. or S.E. winds in the gulf, being changed in direction by the high lands of the South coast, and have, therefore, in general the same foggy character. This is said of winds of considerable strength and duration, and which may extend over great distances. Moderate and partial fine weather winds may occur without Fog at any season, and in any locality. In the early part of the navigable season, especially in the months of April and May, with clear weather, N.E. winds are of frequent occurrence, and they sometimes occur at other seasons, and in every part of the gulf and river.

The Fogs sometimes last several days in succession, and to a vessel either running up or beating down, during their continuance, there is no safe guide but the constant use of the deep-sea lead, with a chart containing correct soundings.

The Fogs which accompany Easterly gales extend high up into the atmosphere, and cannot be looked over from any part of the rigging of a ship. They, however, are not so thick as those which occur in calms after a strong wind, and which are often so dense as to conceal a vessel within hail; whilst the former frequently admit the land or other objects to be distinguished at the distance of half a mile or more, in the daytime.

The dense Fogs which occur in calms, and even in very light winds, often extend only to small elevations above the sea; so that it sometimes happens, when objects are hidden at the distance of 50 yards from the deck, they can be plainly seen by a person 50 or 60 feet up the rigging. In the months of October and November, the Fogs and rain that accompany Easterly gales, are replaced by thick snow, which causes equal embarrassment to the navigator.

NOVA SCOTIA.—The prevailing winds on all the S.E. coast are from W.S.W. to S.W., nearly as steady as *Trade Winds*, excepting that during the summer months they are rather more Southerly, accompanied with but little intermission by fog, which requires a North-Westerly wind to disperse it. It is, therefore, recommended not to leave an anchorage without making arrangements for reaching another before dark; or with appearances of a fog coming on, which, with a S.W. wind, is so sudden, that you are unawares enveloped in it; nor to keep at sea during the night, if it can be avoided. Whenever the wind blows directly off the land the fog is soon dispersed.

In the spring and summer months dense fogs or rain almost always accompany all winds from the sea, from E.N.E., round South, to W.S.W. In winter, the rain is frequently replaced by snow. During the autumnal and winter months, winds from between North and West become more frequent, and, being off the land, are always accompanied with clear weather.

Strong gales of wind do not often occur in May, June, or July; but after the middle of August they are often of great strength, and it becomes the more necessary to attend carefully to the indications of the barometer. Strong winds from East, round South, to W.S.W., are always accompanied by a falling barometer. When, therefore, these winds begin to abate, and the barometer at the same time ceases to fall, a change of wind, more or less sudden, to the opposite direction may be expected, with a rising barometer and fine weather; and if it be winter, with intense frost, coating the vessel, her sails, and rigging, with ice.

Again, a high barometer, stationary or beginning to fall, indicates that a S.E. or S.W. wind, with accompanying rain and fog, is not far distant; and if, at the same time, there be a bank of clouds rising above the North-Western horizon, the indication is certain.

Bay of Fundy.—The prevailing winds in summer are from South to S.W., in autumn from North to N.E. Winds from South to S.W. generally bring fog, which often comes on suddenly. In summer, the haze from burning forests in Maine is almost as bad as fog.

South Carolina, &c.—About this coast, if the wind blows hard from the N.E. quarter, without rain, it commonly continues so for some time, perhaps three or four days; but, if such winds are attended with rain, they generally shift to the East, E.S.E., and S.E. S.E. winds blow right in on the coast; but they seldom blow dry, or continue long. In six, eight, or ten hours after their commencement, the sky begins to look dirty, which soon produces rain. When it comes to blow and rain very hard, you may be sure the wind will fly round to the N.W. quarter, and blow hard for twenty or thirty hours, with a clear sky.

North-West winds are always attended with clear weather; they sometimes blow very hard, but seldom for longer than thirty hours. The most lasting winds are those which blow from the S.S.W. and W.N.W., and from the North to the E.N.E. The weather is most settled when the wind is in any of these quarters.

In summer time thunder-gusts are very common on this coast; they always come from the N.W. quarter, and are sometimes so heavy that no canvas can withstand their fury; they come on so suddenly, that the greatest precaution is necessary to guard against the effects of their violence.

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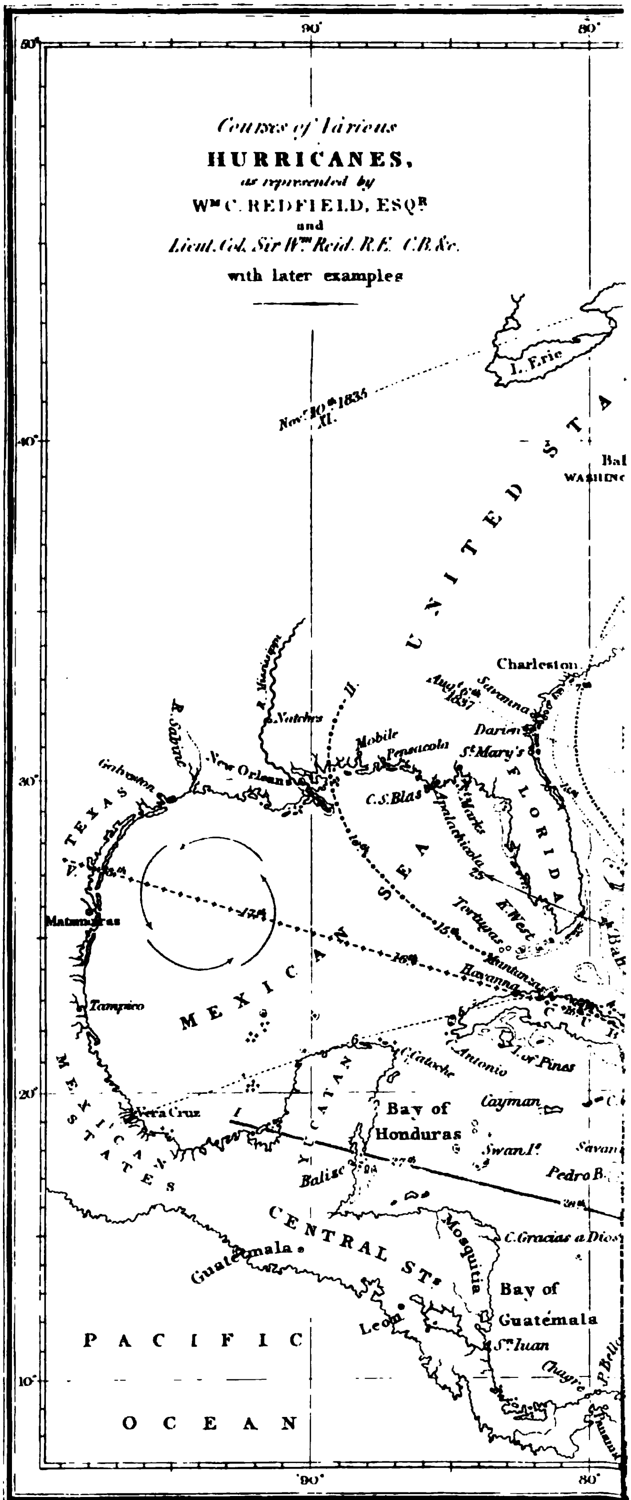

Courses of Various

HURRICANES,

as represented by

W^{m} C. REDFIELD, ESQ^{R}

and

Lieut. Col. Sir W^{m} Reid. R.E. C.B. &c.

with later examples

Publi

9.—HURRICANES.

(151.) Among the most extraordinary phenomena of nature may be classed those tremendous meteors, the Hurricanes and Tornados of the Tropical Regions. There are various names applied to these storms: Cyclones, Revolving Storms, Rotary Gales, Hurricanes, Tornados (Portuguese and expressive "re-turned"), Typhoons, &c.; but all are meant to describe much the same thing. Up to within quite a recent period they were very imperfectly understood, and were only regarded as terrible convulsions of the aerial system, when all order seemed to be broken up. But these, like many other apparent anomalies in nature, have been found reducible to system; and their various seemingly capricious motions all subject to general rules, which, in this case, have been aptly denominated "*The Law of Storms.*"

(152.) **Authorities.**—The discussions on the *progressive* nature of Hurricanes appear to have originated in a paper, entitled "Remarks on the Prevailing Storms of the Atlantic Coast of the North American States," by William C. Redfield, of New York, 1831, which proved to be a very important and valuable addition to nautical literature.* The subject, adopting the "Redfield Theory," was afterwards amplified and illustrated by Lieutenant-Colonel (afterwards Sir) William Reid, R.E., C.B., Governor of the Bermudas and of Malta, in the volume entitled "An Attempt to Develop the Law of Storms by means of Facts, arranged according to Place and Time, and hence to point out a Cause for the Variable Winds, with a view to practical use in Navigation," 1838. As connected with this subject, the names of Redfield and Reid will be imperishable.†

We say that the discussion appears to have originated in the before-mentioned works; but, without deciding on the claims of priority, it must be mentioned that, besides the names of Reid and Redfield, those of Mr. Piddington, at Calcutta; of Dr. Thom, and more recently Professor Meldrum, in the Indian Ocean; of Mr. Espy, in America; and of Professor Dové, at Berlin, must be enrolled with them, as the primary instigators of the enquiry into the origin and nature of Storms. Mr. Piddington's "Hornbook" contains the most valuable information on this important topic.

Among more recent writers on this subject we may mention the Padre

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* The origin of the revolving theory has been attributed to others earlier in the field then Redfield and Reid. Among others, to Colonel Capper, who published his well-known work on Winds and Monsoons, in 1801; to Romme, a French author, in 1806; and to several others. But these all fell short of establishing the law, inasmuch as they only noticed the shifting character of the winds in one spot, and did not reach the conclusion that these shifts had an invariable character, and that the whole meteor was progressive.

† "My attention was first directed to the subject from having been employed at Barbadoes in re-establishing the Government buildings blown down in the Hurricane of 1831, when 1,477 persons lost their lives in the short space of seven hours. I was induced to search everywhere for accounts of previous storms, in the hope of learning something of their causes and mode of action."—*Reid*, "*Law of Storms.*"

Viñes, of Havana; Professors Wojeikof, Mohn, and Hildebrandsson; Messrs. Blanford, Elliott, and Willson, in India; Dr. Doberck and Père Dechevrens, in China; Mr. Knipping, in Japan; Messrs. Birt, Jinman, Evans, Scott, Buchan, Ley, and Toynbee; and Professor Ferrel and Lieutenant Hayden, in the United States. The writings of these gentlemen, with those of numerous others, are chiefly to be found in various periodical publications, and have been used in the compilation of the following remarks, which, it is hoped, will be found to contain the essence of the subject, though there are difficulties in reconciling the many contradictory and confusing statements.

(153.) **Character.**—Although the "Law of Storms" is now fully recognized, opinion is not yet unanimous as to the real character and condition of these remarkable meteors. Reid, Redfield, and others, contend that they are real vortices—currents of air *revolving* round a progressive centre; others, as Thom and Meldrum, contend that the wind blows in *spirals* around this centre; Espy, that the wind blows *toward* the centre; others, again, consider that the *vertical* motion of the air will explain many of the phenomena. Jinman considers that, as the air is blowing away from one area, another current necessarily blows towards and into that area, causing the peculiar features of these Hurricanes. It would be out of place, and far too discursive for this work, to discuss at length these various propositions; they may readily be found in the numerous works extant.

One more remark may suffice. Is it not possible, nay, probable, that each of these theories may be correct as to individual Cyclones, which may be (and are) of such varied character as not to be reducible in all cases to a fixed rule? However, it is certain that in many examples the true Revolving Storm is the proper appellation.

(154.) **Rotation.**—One fact with regard to these Storms appears to be now all but indisputable, and that is the rotary or gyratory character of the winds round a circular, or nearly circular, area or vortex of low barometric pressure, which moves forward at the same time along certain tracks, according to the locality in which it is found. Concerning the rotary character of the winds, simultaneous observations at different positions during the progress of these Storms show there can be no doubt that the winds which formed them were rotating round central areas. The way in which the wind veered at all the places over which it passed, cannot be explained on any other supposition. The depression of the barometer within the areas of the storms, and the circumstance that the depression was greatest everywhere at or near the centre, also indicates another important feature, viz., that there is a diminished atmospheric pressure within the whole area of a Cyclone, and lowest of all at the centre. The diminished weight of the atmosphere at the places passed over by the Cyclone may be accounted for by the suction which draws air towards it from all quarters and the effect of which is necessarily to produce revolving currents ascending spirally towards the area in the upper regions of the atmosphere where a vacuum or great rarefaction originated.

In the paper referred to in (156) is a description of a Waterspout which was seen to extend upward to a height of 1,700 feet, and of several Dust

Storms which were more than double that height. If there be a close analogy between Cyclones and these smaller whirls, it may be inferred that the gigantic whirls composing the former are greatly higher, or perhaps several miles in height, and consequently the direction of the wind experienced during a Cyclone may not always agree with the direction of the progress of the scud above, which may be accounted for by the spiral column not rising perpendicularly in the air. This will be referred to again later on.

(155.) **Incurvature of Wind.**—It is now considered that the wind only blows circularly round the vicinity of the centre or vortex, while at parts of the Storm farther away it does not blow in a strictly circular course round the centre, but spirally or incurving towards it, as shown in the illustrative diagrams. The curve which the wind describes is in reality a spiral around the focus. If these were drawn, that for the Northern Hemisphere would be curved in the same direction as the figure 6; for the Southern it would be this figure reversed, or like the figure 6 on the back of the paper, both beginning at the top.

This indraft or incurvature of the wind varies according to the latitude and also the quadrant of the Storm. Padre Viñes found that, in the West Indian Hurricanes which he had studied, in the front part of the Storm the winds blew almost in a circle, while in the rear the inclination, or indraft, was so great that the winds blew almost towards the centre. When in latitudes higher than 30°, however, the Hurricane may cover so great an area as to render the indraft imperceptible. This indraft of course affects the problem of finding the bearing of the centre, discussed hereafter.

(156.) **Similes.**—Perhaps the idea of an ascending spiral whirl may be the simplest simile to which to compare the circulation of the winds in a Cyclone. In a paper by D. M. Holme, LL.D., published in the Journal of the Scottish Meteorological Society, 1869, pages 305—322, it was pointed out that the whirls which frequently occur in the atmosphere, known as Waterspouts, Whirlwinds, and Dust Storms, often originate in the upper regions of the atmosphere, and descend in the form of an inverted cone to the earth's surface. They are also formed by currents of air ascending from the earth's surface spirally and rotating at the same time. These ascending currents have been distinctly noticed, by various articles (such as hay, straw, branches of trees, and in some cases animals) being seen carried up in the interior of the whirling cylinder. If it were possible to have an aneroid in the interior of it, a depression indicating diminished atmospheric pressure would most probably be observable. In this paper it is attempted to prove that Cyclones have many features in common with Waterspouts, Dust Storms, and Whirlwinds.

(157.) **Origin.**—The most difficult part of the Cyclone theory remains to be mentioned. What causes the *suction* to which the indraught of air may be attributed? What determines the course which all these West India Cyclones take in their passage over the earth's surface? The latter question is the less difficult of the two. If the Cyclones are formed, as they appear to be in the Atlantic Ocean, a little to the North of the Equator, it is evident that they must move in the first instance to the Westward, because the general atmospheric current is in that direction. When they reach the

West India Islands they get into another current, which carries them first N.W., then North, and ultimately N.E.

But how is the whirling cylindrical column of a Cyclone formed? There are several ways in which a whirl may be formed. (1.) If a tub be filled with water, and a small orifice be made in the bottom, the water in the tub as it runs out rotates. At first only the part over and near the orifice rotates, but ultimately the rotation extends to more distant parts. (2.) If a stream of water be made to flow through a body of water which is quiescent, whirls or eddies will be formed which consist of columns more or less vertical. They may be seen any day in rivers where the current passes a point of rock projecting into the stream, and when that current comes in contact with the body of the water sheltered by the rock. These eddies are still more common where two currents, running in different directions, touch one another; along the line which separates them whirls are formed, the rotation being in the direction of the stronger stream, and its progressive motion being also in the same direction. (3.) If a long glass cylinder be immersed a little way into a body of water, and the air be suddenly exhausted or rarefied by drawing it out at the top of the cylinder, the water rises, and in rising rotates.

With regard to the cause of the air rising. There must frequently be, in the upper regions of the Equatorial atmosphere, condensations of the warm vapours which are carried up from the surface of the ocean by the ascending aerial currents. These condensations will produce great rarefaction, and that rarefaction will draw towards it air from the lower regions of the atmosphere, and in drawing it will probably cause rotation.*

Low pressure, violent winds, and heavy clouds and rain, are always observed in well-defined Cyclones, and are closely dependent on one another. A local decrease of pressure, from whatever initial cause, requires the inflow of the surrounding air. The winds thus aroused acquire, except close to the Equator, a rotation around the low pressure centre as they approach it, because they are moving on a rotating sphere. Their inward spiral motion thus begun must become more rapid near the centre in accordance with the well-known mechanical law, as illustrated by a whirlpool. The centrifugal force produced by the rotation causes a further decrease of pressure at the centre, and thereby confirms the circulation of the Storm.

The low pressure at the centre, in spite of the continual spiral inflow of air, shows there must be a compensating escape of air by ascent and outflow above; the slowly-ascending air, still whirling around the centre, is necessarily cooled by its own expansion as it rises, and thus vapour is condensed, and heavy clouds form giving rain. The latent heat given out by the condensation of so much vapour retards the cooling of the ascending air and maintains it at a higher temperature than that of the surrounding air at the same altitude. This relative warmth of the cloudy storm area maintains the outflow of the upper currents in the same way as the Equatorial warmth causes the Poleward flow of the lofty Anti-Trades.

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* To cause this rotation, the ascending current would appear to require a limited space to pass through, and this hole, as it were, might be formed at a point of contact of the upper and under layers of three strata of air. That it is possible for patches of air of different consistencies to exist side by side, has been proved by the fog-signal experiments carried on by the Trinity House.—Ed.

(158.) **Direction of Rotation, &c.**—In the Northern Hemisphere, as already explained on page 183, the winds in Cyclonic Storms invariably revolve from *right to left, past the North, or against the sun,* i.e. in the opposite direction to the hands of a watch lying face upwards. Originating within the Tropics, the Storm progresses bodily to the W.N.W., then N.W., and North, forming a cycloidal curve in about lat. 30°, and runs off to the N.E.

South of the Equator, or in the Southern Hemisphere, *this rule is reversed, the Storm revolving from left to right,* or *with* watch-hands, passing onwards in a S.W., and finally in a S.E. course. These Storms, however, do not seem to be encountered in the South Atlantic Ocean, within the S.E. Trade Wind area.

The illustrative diagrams will give the reader a better idea of the circulation of the wind in a Hurricane, North of the Equator, than any written description. The spiral lines in that for low latitudes show the course of the wind around the vortex, its direction at any point on this diagram being the same as the curve at that point. By plotting arrows at all points having the wind from the same direction, North for example, and joining them by a dotted line, it will be found that this line curves towards the centre. The angle of bearing of the centre therefore, supposing the Cyclone to be of a normal character, gradually decreases from about 10 points (or it may be 11, 12, or 13 points, or even more) of the compass at the margin to about 8 points nearer the vortex, where the "Eight Point Rule," hereafter given, becomes correct.

(159.) **Form, &c.**—A Cyclonic area is rarely circular, but usually more or less oval, seldom perfectly symmetrical, and the vortex or centre is often displaced towards one side. The vortex also sometimes oscillates or moves from one side of the area to the other. The longer axis of the oval usually lies in a line with the path of the Storm, and its effect is as if the circle had been distorted, thus giving a much greater preponderance of the winds due to the longer sides of the oval. An irregular motion of the vortex, as above described, will cause great perplexity and apparent want of regularity, yet the Storm itself may be strictly a revolving one. Another cause of complexity in revolving Storms is, that they have been known to separate into two, and in other cases two or more Storms encountering each other have coalesced.

The vortex or focus of a Cyclone, where reigns a calm accompanied by heavy and confused seas, with a blue sky in the Tropics (known as the "bull's eye"), may be of considerable size, from 10 to 30 miles in diameter in some Storms, and in others, it is thought, may be next to nothing. Here the barometer may read 2 inches or more below the normal. This is the most dangerous part of a revolving Storm, as in its passage the wind suddenly shifts from one point to the other, and here it is generally most violent. Around this the wind circulates in an ever widening circle as it progresses on its course, until the disturbance may cover an area of 1,000 miles or more in diameter.

There is a large amount of variation, however, in the size, shape, and velocity of these Storms. They are smallest and most violent in the Tropics, where the cloud-ring averages about 500 miles in diameter, and the region of stormy winds 300 miles, or even less.

Some examples of vessels passing through the vortex are given at the end of this Section.

(160.) Though the circular theory is now so generally adopted, it is as well here to notice that of Captain George Jinman, who thus expounds his views :—Every Hurricane or Gale has two distinct sides, formed by two currents of air flowing in opposite directions, and crossing each other at two points. The two sides are not always equally developed at the earth's surface—that is, the one often blows harder than the other; it is but seldom, in fact, that the winds in the two sides are equal in force. The greatest force will be found at either *confluence*, but rarely of equal force at both. It may blow with hurricane violence at *both confluences*, and only a moderate gale at the sides.*

The centre of a Storm is not the most dangerous part. There are times in which it would be possible for a steam-ship to pass from one side of the gale to another, across the centre, and yet not experience more than a moderate gale, whilst vessels on either side of her, under the confluences, may be exposed to violent Hurricanes. A vessel may become embayed, as it were, in a Storm, in such a position that it may be almost impossible for her to escape altogether uninjured. There are many positions, indeed, in which a ship, especially a dull sailing one, may be overtaken, and be unable to escape.

One confluence is generally more distinctly marked than the other, especially in extra-tropical latitudes; so much so, indeed, that, for a long time, I imagined that there was but *one ;* which at that time I named the *centre-line*, or *core* of the gale. The one on the West side of the centre, in either Hemisphere, is always more marked than the one on the East side. When I say *more marked*, I mean that the *meeting* of the two winds may be seen more distinctly; as, for instance, in the North Atlantic, when the wind *flies* from S.W. to N.W. This takes place at the confluence on the West side of the centre. On the East side, where the winds forming a confluence are from the S.E. and S.W., their meeting is not so distinctly marked. The wind seldom *flies* from S.E. to S.W.; it more usually *veers*, but rather more quickly than at any other part of the Storm. The reason is simply this: the S.E. and S.W. winds, flowing out from the Equator, are more highly charged with vapour, and are warmer than a Westerly or Northerly wind, and consequently have a greater tendency to ascend and to mix with each other. A N.W. wind, on the contrary, is a dense, cold wind—a descending wind; and on coming in contact with a S.W. wind, it condenses the vapour which the latter has taken up, thus producing torrents of rain at their junction. Here we have one material proof that the winds do not blow in circles; for, on passing from one wind into another, as from a S.W. into a N.W., a long bank of *nimbus* (rain-cloud) may often be seen stretching away from S.W. to N.E., or with the wind just left, and at right angles to the wind entered, before which it is being rapidly driven; showing distinctly that the two winds are in contact, and blowing at right angles to each other. This could not be the case if the wind blew in circles—if it was one continuous current of air blowing round a centre.

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* I am satisfied that many of those Storms which have been described by some writers as *double* Hurricanes or Cyclones, were nothing more than the two confluences of the same Storm.

(161.) **Season.**—West Indian Hurricanes, as Tropical Cyclones in the North Atlantic Ocean are generally called, are especially liable to be encountered from July to October inclusive, though June may also be numbered among the Hurricane months. October, although the last month of the Hurricane season, is one of the most dangerous. August is specially liable to these dreaded Storms, the maximum being reached between the middle of August and the middle of October. They are comparatively rare during the other months, though not entirely unknown. The following is a list of 355, which occurred in the West Indies during a period of 363 years, arranged according to the months, taken from a chronological Table drawn up by M. André Poey, of Havana, for the years from 1493 to 1855.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
5	7	11	6	5	10	42	96	80	69	17	7	355

June, too soon; July, stand by;
August, look out you must;
September, remember; October, all over.

This rhyme is true so far as the *specially* dangerous months are concerned. The experience, however, of over 300 years records, shows that June is not too soon, and that in October they are not all over.

(162.) **Regions.**—West Indian Hurricanes originate in the Tropics, usually to the Westward of long. 40° W., and rarely to the Southward of lat. 10° N.* As a general rule, their origin seems to be about the Northern edge of the belt of Equatorial rains and calms, to the Eastward of the Windward Islands. Starting as whirlwinds on a gigantic scale, they at first move bodily Westward, sometimes crossing the Gulf of Mexico and reaching the coast of the United States with destructive violence; but more often curving to the Northward and North-Eastward, following up the Gulf Stream towards Newfoundland, and then inclining away to the Eastward around the area of high pressure over mid-Atlantic.

Thus they may be encountered anywhere within the Tropical limits given above; also over the Caribbean Sea and Gulf of Mexico; over a broad belt curving North-Westward from about St. Thomas, including the whole area from Bermuda to the United States coast and British America. Farther to the North-Eastward these Storms gradually lose their distinctive character, though their tracks can at times easily be traced across the Atlantic towards Northern Europe.

Cyclones are rarely, if ever, formed to the South of the mid North Atlantic Anti-Cyclone, mentioned in (25), though they sometimes originate on its S.W. side. On the North side of this Anti-Cyclone, Cyclonic areas frequently arise, moving away to the Eastward. On its S.E. side, near Madeira, Cyclones are also occasionally formed; these either work very slowly to the S.W., or cross over towards the Strait of Gibraltar.*

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* See Captain Henry Toynbee's remarks, given *ante*, on page 138.

The lowest latitude of any centre of low pressure which has been distinctly traced in the North Atlantic Ocean is 6° 6′ N., and there are eight cases of Cyclonic Storms whose paths have been traced to points South of lat. 10° N. Hard gales and violent squalls of wind sometimes occur directly under the Equator.†

(163.) **Path or Track.**—We have before stated (158), that besides its circular motion the Cyclonic Storm also moves forward bodily along certain tracks, according to the locality in which it is found. The investigation of the records of a very large number of West Indian Hurricanes has led to the following conclusions with regard to the tracks which they generally follow, though, as will be seen from the practical examples hereafter given, no dependence can be placed upon any Storm following a certain track, so much depending upon the meteorological conditions of the area surrounding it.

Professor W. Ferrel well describes the progressive motion of a Cyclone as depending mostly upon the general motions of the atmosphere, but also upon the tendency of the Cyclone to press towards the Pole. In the Trade Wind latitudes the wind at the earth's surface is Westward, or at least has a large Westerly component, and hence the Cyclones in these latitudes are carried Westward by this Westward motion of the air, especially at certain seasons; and having likewise a tendency toward the Pole, the resultant of the two is a Westward motion, inclined a little toward the Poles, or in the Northern Hemisphere a motion about W.N.W. After having arrived at the parallel of 20° to 33° or 35° in the Tropical calm belt, where there is no Westward motion (according to the season), the progressive motion is a Polar one mostly, but after progressing still nearer the Pole, into the middle and higher latitudes, the general Eastward motion of the atmosphere here, which is great in the upper regions, now carries the Cyclone towards the East, and the direction of the progressive motion, which is usually about E.N.E., is the resultant of this Eastward motion and the motion towards the Pole. All well-developed Cyclones, therefore, having their origin in the Tropics, have mostly a progressive motion represented by a curve somewhat in the form of a parabola, as will be seen from the diagram showing the courses of various Hurricanes.

Padre R. P. B. Viñes, of Havana, as the result of his study and long experience of this subject, states that between lat. 10° and 15° N. a Hurricane moves almost due West.

In June and October its course changes rapidly to N.W. and North, *recurving* about lat. 20° to 23°.

In July and September it continues on its N.W. course to lat. 27° to 29° before *recurving*.

In August it continues on its N.W. course to lat. 30° to 32° before *recurving*.

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* "Weather," by the Hon. R. Abercromby, 1887.

† Prof. E. Loomis, "On Areas of Low Pressure," American Journal of Science, 1885.

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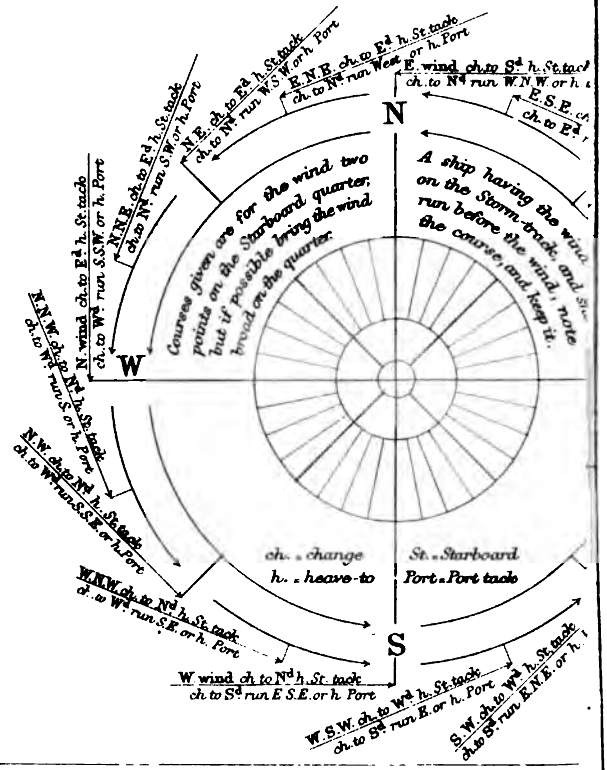
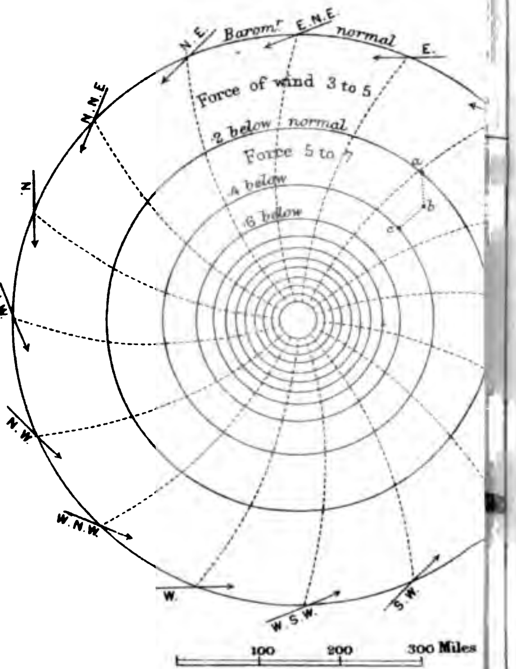

N
S
W
N.E. ch. to E^{d}. h. St. tack
ch. to N^{d}. run W.S.W. or h. Port
E.N.E. ch. to E^{d}. h. St. tack
ch. to N^{d}. run West or h. Port
E. wind ch. to S^{d}. h. St. tack
ch. to N^{d} run W.N.W. or h.
E.S.E. ch.
ch. to E^{d}.
N.N.E. ch. to E^{d}. h. St. tack
ch. to N^{d}. run S.W. or h. Port
N. wind ch. to E^{d}. h. St. tack
ch. to W^{d}. run S.S.W. or h. Port
N.N.W. ch. to N^{d} h. St. tack
ch. to W^{d}. run S. or h. Port
N.W. ch. to N^{d} h. St. tack
ch. to W^{d}. run S.S.E. or h. Port
W.N.W. ch. to N^{d} h. St. tack
ch. to W^{d}. run S.E. or h. Port
W. wind ch. to N^{d} h. St. tack
ch. to S^{d} run E.S.E. or h. Port
W.S.W. ch. to W^{d}. h. St. tack
ch. to S^{d}. run E. or h. Port
S.W. ch. to W^{d}. h. St. tack
ch. to S^{d}. run E.N.E. or h.
ch. = change
h. = heave-to
St. = Starboard
Port = Port tack

Courses given are for the wind two points on the Starboard quarter, but if possible bring the wind broad on the quarter.

A ship having the wind on the Storm-track, and run before the wind, note the course, and keep it.

Diagram *for finding a ship's position relative to t Storm centre, by means of the direction of the wi and fall of the Barometer. (See instructions on*



At the beginning of the season some of the Hurricanes of June and July keep well to the South and cross the Caribbean Sea, and at times also the Island of Cuba, in a W. by N. direction approximately. From the beginning of August to the end of September these Tropical Cyclones, in the first part of their track, take generally a W.N.W. direction or a course between W.N.W. and N.W., and all of them recurve outside of the Tropics, generally between lat. 27° and 33°.

As the season advances, the initial direction of the tracks inclines more to the Westward, the Hurricanes keep farther South and recurve in lower latitudes, so that those of October, and even some at the end of September, come to us (at Havana) from the Southern part of the Caribbean Sea, and recurve in the vicinity of the Tropic of Cancer, or before reaching it, with this peculiarity, that where several have come in succession, each one has recurved not only in a lower latitude, but also farther West than the preceding. The interval in these cases from one to another is not less than twelve or fourteen days. These Hurricanes are without doubt the most to be feared for the Western portion of the Island of Cuba.*

The illustrative diagrams, mainly derived from the United States Pilot Chart of the North Atlantic Ocean, show the circulation of the winds in a normal West Indian Hurricane. The large arrows show the direction of the path along which the Storm is advancing, according to the latitude; the small arrows fly with the wind, and show the indraft or incurve towards the centre. The central shaded portion shows the specially dangerous region, and the right hand side of this, facing the Storm's path, is the *dangerous semicircle*, about which more will be said later on.

(164.) Mr. Redfield says:—At stations within the Tropics, the changes of wind, during the passage of the Hurricane, are sometimes known to *exceed* those which pertain to the passage of a regular circuit of wind; these changes sometimes running through the entire circuit of the compass, and even more. Again, they have been known to shift *backward and forward*, in alternate and fitful changes, when near the crisis of the Storm. These phenomena, so far from disproving the rotative character of these gales, only prove something more, and afford, at least, probable evidence in support of one or both of the following positions:—1. That high land and other obstructions often produce sudden and fitful gusts and changes in these violent winds. 2. That, in accordance with our observations of minor vortices, the action of rotation is often impelled, excentrically, around a smaller circuit, in the interior of the advancing Storm.

In the Northern inter-tropical latitudes the recession or departure of the South-Eastern limb of the Storm appears to be followed, not unfrequently, by strong squalls or gusts from the S.E., this being the true course of the general Trade Wind which determines the track of the Storm. These gusts, or squalls, if mistaken for the regular action of the Hurricane, may occasion erroneous deductions in regard to the course of the Storm.

At stations apparently within the regular track of the Storm, there will sometimes be an absence of violent wind; or the violence will pertain to only one of the phases, which the Storm presents, in its regular course over such locality.

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* "Apuntes relativos a los Huracanes de las Antillas en Setiembre y Octubre de 1875 y 1876," by Padre R. P. B. Viñes.

Some Storms are interrupted in their development by the near approach of another Storm. Care must be taken, therefore, not to mistake the N.E. wind of a Storm whose North-Western limb is thus intercepted by a bordering Storm, and which hence is sometimes followed by the natural current of air from the S.W. quarter, for the changes that pertain to the centre of a rotary gale.

(165.) **Velocity.**—The velocity or force of the wind in a Cyclonic Storm varies according to the distance from the vortex, being least near the circumference, and greatest near the central calm space, where it has been estimated sometimes to attain a speed of 125 to 150 miles an hour.

With regard to the rate of progression of the storm-field along its track, the examination of a large number of records has led to the following results. At its origin, and in low latitudes, its average rate of movement is 17 miles an hour, but this is reduced to 10 or 5 miles an hour where the storm recurves in middle latitudes, and here it has even been known to become almost stationary for several days. As it bears off to the Eastward its speed increases to 20 or 30 miles an hour, though Professor Loomis, from his researches, finds they here attain an average speed of only 18 miles an hour.

From their nature there must necessarily be considerable variation in the course and velocity of these Storms, but the above figures give the average.

(166.) **Indications.**—The earliest and surest of all warnings of an approaching Hurricane will be found in that invaluable, and seldom-failing monitor, the *Barometer;* the language of which, in the Torrid Zone, is unmistakable, because there it is usually tranquil and undisturbed. When any such warning symptoms are observed, in *any* quarter of the world, it may be supposed that no time should be lost in making all due preparation, and especially if to such menacing appearances be added the confused and troubled agitation of the sea which often precedes these revolving storms, and always shows that they are at no great distance. But if these combined prognostics should occur within the limits of those regions in which these Cyclones occur, let the seaman immediately consider the possibility, at least, of his being about to encounter a storm of that revolving type of which we have been treating.

The Barometer will be found an unerring indicator of the approach of these meteors, provided proper attention be paid to its monitions. As a general rule, the following will be its usual vibrations:—Just previous to the commencement of the Hurricane, the mercury will suddenly rise above its normal or ordinary level (see (23) and the accompanying diagrams of Mean Barometric Pressure), accompanied by Anti-Cyclonic winds of some duration, with cool, dry, bracing, and beautiful weather, a clear sky, and very transparent atmosphere.* In a day or two, or sooner, it will begin to fall, and the wind probably rises, showing that the Storm has begun.

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* The Hurricane of September, 1885, was thus indicated at Havana, while it was yet 1,200 miles away.

The mercurial column then begins to descend, rapidly at first, and then more slowly, till the centre of the Hurricane has passed over, when it begins gradually to rise, and the reverse of the commencement ensues; it attains a higher level, and then as suddenly falls to the mean height. This is if the whole of the meteor pass over it, and the centre be crossed.

Upon a little consideration, it will be evident that the form of the surface of the revolving storm, or the section of the vortex, is described by the variations in the barometric column. It by no means follows that, practically, this will always be found: a ship may only skirt the exterior of the storm, and, consequently, the mercury will only rise, or oscillate, according to the relative position of the Hurricane and the ship; but it may be taken as an indication, when the barometer begins slowly to rise, after being depressed, that the greatest danger has passed over, or that the ship is steering away from it. Therefore, should there be any sudden change in the barometer, either rising or falling, its indications should never be neglected, especially during the period, and in the regions, subject to these storms. The barometer sometimes sinks *two inches* during the progress of a Hurricane.*

One great advantage in the Aneroid Barometer is, that its variations occur simultaneously with their causes. In the Mercurial Barometer the friction of the mercury on the tube, and other reasons, concur to make the column rise or fall at some time after the change has occurred. In this the Aneroid Barometer possesses great advantage, and it has another very great claim to notice—that it clearly shows very minute changes, which the oscillation or pumping motion of the mercury in very bad weather will not allow to be estimated.

Another warning of the coming Storm is a long low swell from the direction in which it is approaching. In the open ocean, when the waves have free action in deep water, the unbroken swell of the ocean travels with immense velocity, rising at times to about 400 miles an hour. Any extraordinary swell or rollers, more or less confused, may be taken as the evidence of some distant Storm. Another early sign is when light feathery *cirrus* clouds are seen radiating from a point on the horizon where a whitish arc indicates the bearing of the centre, though it may still be hundreds of miles away. Unmistakable signs are a falling barometer; halos about the sun and moon; increasing swell; hot, moist weather, with light variable winds; rolled and tufted forms of clouds, with deep lurid red and violet tints at dawn and sunset; a heavy mountainous cloud-bank, of a dark or leaden appearance, on the distant horizon, with darting forks and threads of pale lightning.† This cloud-bank may be seen, perhaps, twelve hours before the wind comes on. The peculiar *cirro-stratus* clouds, the invariable precursors of the Hurricane, soon appear, looking like white and delicate feathers or great and showy plumes crossing the firmament. These beautiful clouds remain fixed at times, and do not change their forms for hours. The weather becomes heavy, the heat oppressive and sticky, causing profuse perspiration, and the humidity of the air increases. In a short time the *cloud-bank* of the Hurricane appears on the horizon, the wind freshens every moment, and the first *nimbus* and broken *cumulus* clouds commence to disintegrate and fly about with gusts, light rains, and passing squalls. These increase in number and intensity, with the more rapid fall of the barometer, as the storm-centre approaches. Electrical discharges are rarely seen at this period.

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* At midnight, December 22nd, 1892, the corrected reading of the barometer on board the steamer *Werkendam*, was 27·75, near the centre of a Hurricane, in lat. 39° 41′ N., long. 30° 41′ W., one of the lowest readings recorded in the North Atlantic Ocean (see page 111).

† Although it is true that the prognostics of a common coming storm are, in general, sufficiently plain to be understood by a spectator, from the angry appearance of the firmament, yet it is also true that there is no particular indication in any one quarter of the horizon sufficiently marked, like the space occupied by the *Black Squall* panoply of the Caribbean Sea, so that an acute seaman may say, "thence will the blast come." On the contrary, the clouds gather together (we speak from experience) in dense masses,

Lieutenant E. Hayden, U.S.N., remarks that one of the most important indications of an approaching Hurricane is the marked cyclonic circulation of the wind and the lower and upper clouds. A Cyclone is an ascending spiral whirlwind, with a rotary motion against the hands of a watch in the Northern Hemisphere. The *surface* wind blows spirally inward, being only circular very near the centre; the current above, carrying the low scud and rain clouds, blows in almost an exact circle around the centre; the next higher current, with *cumulus* cloud, in an outward spiral; and so on, up to the highest *cirrus* clouds, which radiate directly outward. The angle of divergence between the successive currents is almost exactly two points of the compass. Ordinarily, with the wind from North, the low clouds come from North also, but on the edge of a Hurricane when the wind is North, the low clouds come from N.N.E. *invariably*. In the rear of a Hurricane, the wind blows more nearly inward; thus, with a S.E. wind the centre will bear about West, the low clouds coming from S.S.E.

Great activity of movement of the upper clouds, while the Storm is still distant, indicates the Hurricane to be of great violence. If the radiating cirrus plumes are faint and opalescent, fading gradually behind a slowly thickening haze, the approaching Storm is an old one of large area; if of snowy whiteness, against a clear blue sky, it is a young Cyclone of small area but great intensity.

Padre Viñes' remarks are given later on, in (169).

(167.) **Storm Centre.**—It will be very readily understood that the whole care of the shipmaster, when he first encounters a Storm, is to know how it may be avoided, or otherwise its destructive effects may pass over his vessel in its utmost fury. When the first force of the expected Hurricane reaches his ship, the first point that requires to be known is on what part of the circumference the vessel may be; that being ascertained, it is usually comparatively easy to get out of its way, or at least to avoid its worst effects. Occasional disasters must occur, in spite of all human fore-

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of a cinereous hue, in every direction, until the whole canopy of heaven is overspread, and the gloom at last becomes so intense that, even at mid-day, to speak within bounds, beyond a quarter of a mile no object can be even indistinctly seen. There are, however, some degrees of variation in the intensity of the obscurity; but we all know that the measure of distance by the eye upon such an exciting occasion is not likely to be very exact; at one period in a Hurricane, just as the ship was dismasted, at the *crisis*, near noon, we could not clearly distinguish the end of the bowsprit from the quarter-deck.—*Lieutenant Evans.*

sight; but a careful study of what has been stated, together with the following remarks and rules, should enable any shipmaster to see the approach of one of these dreaded Storms with some amount of equanimity. When there is abundance of sea-room, the danger of these Hurricanes becomes very much diminished, and the mariner is left much more free to choose the best course for avoiding their fury.

There is one position in which a ship may enter a revolving Storm which is attended with the utmost danger, that is directly in its path. In this case the wind will not shift, as it would on either side of the line of progress, but will continue in its first direction until the centre or focus be passed, when it would *suddenly* shift to exactly the opposite point, a change which the seaman would dread. The focus, as before mentioned, is the most dangerous part of the Hurricane, as there the strength of the wind concentrates, sudden shifts of wind take place, and heavy and confused seas break. It is obvious that the nearer the vortex is approached the quicker the shift of wind will be, and *vice versa*. Here, too, the sea becomes confused; the waves raised by the opposing winds surrounding it here interfere with each other, and the appearance, as described by some, is that of the water rising and falling in pyramidal heaps, the usual succession of waves being obliterated. Sometimes the sea rises or subsides in a very sudden manner.

(168.) **Bearing of the Centre.**—The description of these Storms must be carefully studied, to avoid getting entangled in the central regions of the Cyclone, where fierce squalls and heavy seas often make it dangerous for any vessel, even a high-powered steamer, to manœuvre in such a way as to run out of the Storm.

The natural inference from what has been stated in the foregoing pages, concerning the form and movements of these Storms, is that the shipmaster's first care must be to avoid their centre and path, and, to do this, certain clear rules have been evolved, by which the bearing of the centre and the track of the Storm may be readily ascertained with some amount of certainty. For, as we have already stated, it is one of the remarkable laws of these storms that in opposite Hemispheres they revolve in opposite directions—in *North* latitudes *against* the course of the sun, that is to say from *right to left*, or in a direction contrary to the movement of the hands of a watch; and in *South* latitudes from *left to right;* and, secondly, it is known that, no matter how great or how little may be the size of the storm-field, the wind continually blows in a more or less circular course round and round a centre or vortex. It therefore necessarily and demonstratively follows that this centre must always be more or less at right angles to that circular course; or, in other words, that the bearing of the centre lies from eight to thirteen (or more) points of the compass from the direction of the wind, as stated in (158). In (155) it is also shown that in the rear of a Cyclonic Storm the wind sometimes blows nearly directly towards the centre.

The accompanying diagram is taken from the United States Pilot Chart of the North Atlantic Ocean, September, 1887, and may be used as a general guide for action when a Hurricane of normal character is met with Here dotted lines are drawn from each wind-arrow at the margin to the centre, in the way explained in (158), so that to find the direction of the wind at any point follow the dotted line out to the margin and read it there. The circles are *Isobars*, see (24), and the barometer falls ·20 inch from one of these circles to the next. This illustrates very clearly the rate at which the barometer falls as you approach the centre—at first slowly, as the broad outer ring is traversed, then more and more rapidly. Near the centre, where the Isobars are very close together, it has been known to fall an inch in 50 miles. Of course, as you recede from the centre, the barometer rises as you pass from one Isobar to the next.

Lieutenant E. Hayden, U.S.N., gives the following example to show the use of this diagram.

Suppose that on a certain day at 4 p.m., for instance, the wind is E.S.E., and the barometer ·20 inch below the normal: Find at the margin of the diagram the wind-arrow marked E.S.E., and follow the dotted line in toward the centre as far as the Isobar marked "·20 inch below normal;" this intersection (marked *a*) is your position on the diagram; for, by the method of construction just explained, this is the place, and the only place, where, at the same time, the wind is E.S.E., and the barometer ·20 inch below the normal. Referring to the compass and scale which accompany the diagram, you will find that the centre (LOW) bears S.W. by S., distant 250 miles. Plot this 4 p.m. position of the centre on your track chart, from the 4 p.m. position of your vessel.

Later in the day, say 8 p.m., suppose that the wind is S.E. by E., and the barometer is ·30 inch below the normal (having fallen ·10 during the interval): With this wind your position must be half-way between the dotted lines leading in towards the centre from the arrows marked S.E. and E.S.E., and with this barometer reading it must be half-way between the Isobars marked "·20 inch below normal" and "·40 below;" it is therefore at the point marked *b*, and the centre bears S.W., distant 200 miles. Plot this 8 p.m. position of the Cyclone centre on your track chart in the same way as before.

You thus have the position of the Cyclone centre at 4 p.m. and at 8 p.m. plotted on your chart, and the line joining the two positions is the track of the centre and the distance it has moved in 4 hours.

Suppose, again, that at 10 p.m. the wind is still from S.E. by E., but the barometer stands ·40 inch below normal, having fallen ·10 in 2 hours. Your position is now at the point marked *c* on the diagram, found by exactly the same course of reasoning as before, and the centre now bears S.W., distant about 175 miles. Plot this 10 p.m. position in the same way on your track chart. If you have been lying-to, this will evidently indicate that the storm's track has recurved, and that you are directly in front of the centre. But no matter whether you have been lying-to or not, your vessel's track and position at any time, and the track and position of the cyclone centre, are both plotted on your chart, and you can closely watch every change of relative position in order to avoid the centre and dangerous semicircle of the Hurricane.

With regard to the use of this and similar diagrams, the Hon. R. Abercromby remarks:*—Sometimes good results are thus obtained, but I am of opinion, considering the oval and varying nature of a Cyclone's form, and the great differences in the rate of barometric fall, that the application of any such calculation or projection must be illusory.

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* "Journal of the Scottish Meteorological Society," 1889, page 328.

(169.) Padre Viñes, of Havana, in the pamphlet mentioned in the note on page 225, remarks as follows:—For an observer who has to rely solely on his own personal observations, as is the case with seamen, it is of the greatest importance to be able to determine with the closest possible approximation the bearing of the centre at different times and during different phases of the Hurricane. The following indications, deduced from the appearance and disposition of the clouds, and from the direction of the air currents, will be of great utility.

1. As soon as the upper region commences to cloud over, the *cirrus* veil appears most dense in a particular part of the horizon where a whitish arc is formed which, when the sun rises and sets, changes to an intense dark red. This *cirrus* arc forms part of a misty aureole which surrounds the Hurricane, and is, consequently, the first indication which enables us to fix its bearing.

2. It has been observed that the *cirro-stratus* clouds (166) are so situated that their focus of radiation or divergence nearly corresponds to the bearing of the centre. This is considered a very good indication, and is fortified by numerous observations.

To readily determine the position of this focus, it is only necessary to observe that when several of these *cirro-stratus* clouds diverge materially, and consequently are at some distance from the zenith, we must suppose them prolonged to the point of meeting. This should also be done when the *cirro-stratus* clouds show a slight curvature due to rotation, which has been observed in a few instances.

3. The *cloud-bank* of the Hurricane presents itself above the horizon so that its centre nearly corresponds to the bearing of the storm centre. In order to distinguish it easily and not confound it with the squall clouds, particularly when the horizon is indistinguishable, it is necessary to note the following indications:—

The cloud-bank of the Hurricane is distinguished from any other cloud by its *appearance*, by its *relative fixity of position*, by the *movements of the squalls*, and by the *direction which the scud takes in relation to it.*

Its *appearance* is that of a *cumulo-stratus* cloud, which is formed in its upper part by a combination of rounded and cone-shaped clouds, while its lower part consists of a very dark *nimbus* cloud, whose base cannot be seen. The *nimbus* of the squall has no particular form; its base, however, is sometimes well defined, forming a dark band above the horizon.

As to its *relative fixity of position*, it is evident that the cloud-bank of the Hurricane does not move readily from one point of the horizon to another, but remains for a long time in one position, or moves very slowly, particularly during its first phases. The clouds of a squall, on the contrary, appear in different parts of the horizon and change position frequently.

With respect to the *movements of the squalls*, it is seen that these at first disengage themselves from the cloud-bank, and then diverge. The *cumulus* clouds, which are first seen near the middle of the cloud-bank, assume gigantic proportions as they rise towards the zenith, gradually spreading out and covering the sky. Very soon appears the base of the cloud forming above the horizon the dark band characteristic of the squall. With this cloud comes the rain, when the wind freshens and veers immediately to the right, blowing sometimes almost directly from the cloud-bank, which, when the squall has passed, is seen in the same point of the horizon as before. Later, the squalls arise from one extreme of the cloud-bank and follow more or less closely the general movement of rotation.

Finally, if the *direction of the scud* above the cloud-bank be noticed, it will be seen that it flies parallel to it as it rotates, so that an observer who is looking at the cloud-bank sees the clouds fly always from left to right in horizontal lines; thus, if the cloud-bank bears South, the clouds above it fly horizontally from East to West. This does not happen when the observer looks at any other point of the horizon where there may be a heavy cloud, as he will soon see that the scud does not fly in horizontal lines, nor does it move from left to right relatively to himself.

The *low clouds* in the interior of the Hurricane fly ordinarily in directions nearly perpendicular to the bearing of the centre, and consequently, applying the Law of Storms to the direction of these clouds, a much closer approximation will be obtained in the determination of the bearing of the centre than if the same Law be applied to the direction of the winds on the outer edge of the Hurricane. The same may be said of the violent gusts of the squalls if the wind veers always to the right, and its convergence is lessened or done away with altogether.

The *cumulus*, *cirro-cumulus*, and *cirrus* clouds which precede the Hurricane generally diverge, that is to say, their direction forms, with the bearing of the centre, an angle less than eight points, with the very noticeable peculiarity that if different strata are observed it will be seen that the divergence increases with the elevation. The gusts of the first squalls which break away from the cloud-bank also diverge.

The following Table shows graphically the approximate bearing of the centre, according to the observed direction of the movement of *nimbus* clouds and squalls; in fact, it is the old Eight Point Rule applied to them. The bearings for the intermediate points can easily be found.

If the *nimbus* clouds	and squalls	move North,	the centre will	bear East.
„	„	N.E.	„	S.E.
„	„	East	„	South.
„	„	S.E.	„	S.W.
„	„	South	„	West.
„	„	S.W.	„	N.W.
„	„	West	„	North.
„	„	N.W.	„	N.E.

(170.) **Rules, &c.**—Having endeavoured in the foregoing pages to give a succinct account of Hurricanes and their attendant phenomena, we now proceed to the rules and directions which have been given by various authorities to avoid their violence, as deduced from the barometer and weather phenomena.

On the first suspicion of a Hurricane, lie-to or stop the engines, and make everything fast. Being stationary, the shifts of wind are more easily observed, so as to determine in what part of the Storm the vessel is involved, and the approximate bearing of the centre. Also carefully and frequently observe and *record* the changes of the barometer, and the direction of the wind and lower clouds.

First and foremost we give the old time honoured Eight Point Rule for finding the approximate bearing of the centre, though, as previously stated in (155), from recent advances in our knowledge of these Storms, the old rules for dealing with them need revision, especially in low latitudes. Rules based upon the strictly circular theory of the wind (see "Storm Card" diagram, page 230) may be reliable near the centre and in high latitudes, but nearer the Equator become unreliable.

Eight Point Rule.—Look to the wind's eye—note its bearing by the compass—take the eighth point to the **RIGHT** thereof—and that will be the bearing of the centre of the storm if in North latitude; or, if in South latitude, it will be the eighth point to the **LEFT** of the direction of the wind. For example: Suppose the vessel to be in lat. 14° N., with a gale of wind from E.S.E., and the barometer and sky indicating a Cyclone—then look at the compass, take the eighth point to the *right* of E.S.E., and S.S.W. will be the bearing of the brewing storm, *if it be* of a revolving type; or, under similar appearances of the weather, in lat. 14° S., with the wind S.W., take eight points to the *left* of S.W., and S.E. will consequently be the direction of the centre of the impending gale. In the former case, the vessel will be on the Northern edge of the storm-field; and in the latter, she will be somewhere in its North-Western segment.

The Eight Point Rule gives only an approximate idea of the bearing of the centre, and it is probably less reliable in the dangerous than in the navigable semicircle. For instance, with the wind from N.E., the centre may bear anywhere from South to S.E.; with the wind East, it may bear from S.W. to South; and with the wind S.E., it may bear S.W., West, or even W.N.W. in the Tropics.

The best rule is that:—The centre bears about eight points to the right of the direction from which the low clouds come, or, what is the same thing, eight points to the right of the wind at the moment of a sudden shift in a heavy squall. After such a shift, the wind will remain steady in direction for a time, but the centre is meanwhile moving along, and the angle of bearing changes until the next shift, when it becomes eight points again.

(171.) **Line of Progression.**—Having ascertained approximately the bearing of the centre, the next step is to ascertain its probable distance, and the path along which it is moving, for which the reader is referred to the diagrams, and the remarks on pages 229—232.

(172.) **Dangerous and Navigable Semicircles.**—From what has been stated, it needs but little consideration to show that, for a sailing vessel especially, one part of the Storm must be more dangerous than the other, and that is the right-hand semicircle facing its path, as here the winds may drive her in front of the Storm's track, where she may be overwhelmed by the vortex. A steamer, on the other hand, with plenty of sea-room, should have no difficulty in manœuvring so as to avoid it.

By the diagrams it will be seen that the winds of the Dangerous and Navigable Semicircles of a Revolving Storm depend much upon the latitude; at any given position in the Dangerous Semicircle, with a vessel hove-to, the winds will be found to *veer*, while they *back* in the Navigable Semicircle. It is especially dangerous to encounter a Hurricane during its recurve, as it then slows down and sometimes remains almost stationary for several days, the spirally in-blowing winds tending to involve a vessel deeper and deeper in the Storm.

Cool weather is characteristic, in extra-tropical regions, of the Navigable Semicircle, owing to the indraught from the North-Westward. Warm weather, on the contrary, indicates the Dangerous Semicircle where the air is drawn from the South-Eastward.

The Hon. R. Abercromby remarks:—The so-called Dangerous Semicircle owes part of its bad reputation to the fact that the weather is usually more severe on that side than the other. The reason ordinarily assigned for the epithet "dangerous" is that a ship running before the wind in that semicircle will cross the path of the Storm in front of the vortex; while a scudding ship in the other semicircle will cross behind the vortex. This is perfectly true; but the whole character of the weather is also more severe, because the highest pressure, strongest wind, and worst weather are usually found on the side of the Dangerous Semicircle.[*]

Mr. Meldrum, the well-known meteorologist, has established the fact that when a Hurricane occurs in the Trade Wind area, a belt of intensified wind is usually formed on its Polar side, in which there is a falling barometer with increasing wind, making it difficult to discover whether the vessel is really involved in the Storm. In this case, not until the barometer has fallen at least six-tenths of an inch, is it safe to assume that, because the Trade Wind increases in force and remains steady in direction, you are on the line of advance of the Storm. By attempting, under this impression, too early to cross its track, running free as soon as the wind begins to freshen, you are liable to plunge directly into the vortex.

(173.) In order to simplify the remarks concerning the shifts of wind which a vessel hove-to will experience during the progress of a Cyclone, and to render them perfectly clear, a copy of the figure on page 235, by the late Lieutenant Evans, who wrote on this subject under the name of "Stormy Jack," may be drawn on thick paper or card-board. The outer circle, to be *fixed*, represents the points of the horizon; the inner circle, to be movable, and attached, with a button in the centre, so as to revolve on the outer or under circle; thus the inner circle may represent the *phases of the wind*, as it gyrates round a centre, the *arrows* showing the revolution of the aerial current from right to left. The movable circle is sub-divided into four quadrants, with the *phases* of the wind marked on the rim, for the purpose of facilitating the mode of operation.

(174.) *To use the instrument*, formed as above, place the movable circle upon the under one, East in juxtaposition with the North point of the horizon. The vessel's position may be marked as a stationary spot on the outer circle—say under the N.N.W. verge, where the wind, as shown by the *arrow* and corresponding line on the inner or movable circle, will be from E.N.E.; then revolve the upper circle in the direction of the arrows, and the changes of the wind will be seen as they occur progressively on the spot marked, supposing the storm to be encountered in low latitudes, when on its line of progression to the North-Westward. It will thus be seen that on the N.E. verge of the Hurricane, the wind will come from the S.E.; on the North verge the wind will be East; and if on the West it will be Northerly, as shown in the figure. Thus, the changes of the wind will be to the Eastward, going round to the S.E. and South, and ending with it at about S.W. by S. The subject, when considered, will be readily understood; only bearing in mind that the shifts of wind will appear, *in most cases*, to be from *left to right*, *while the wind is actually revolving in the contrary direction.*

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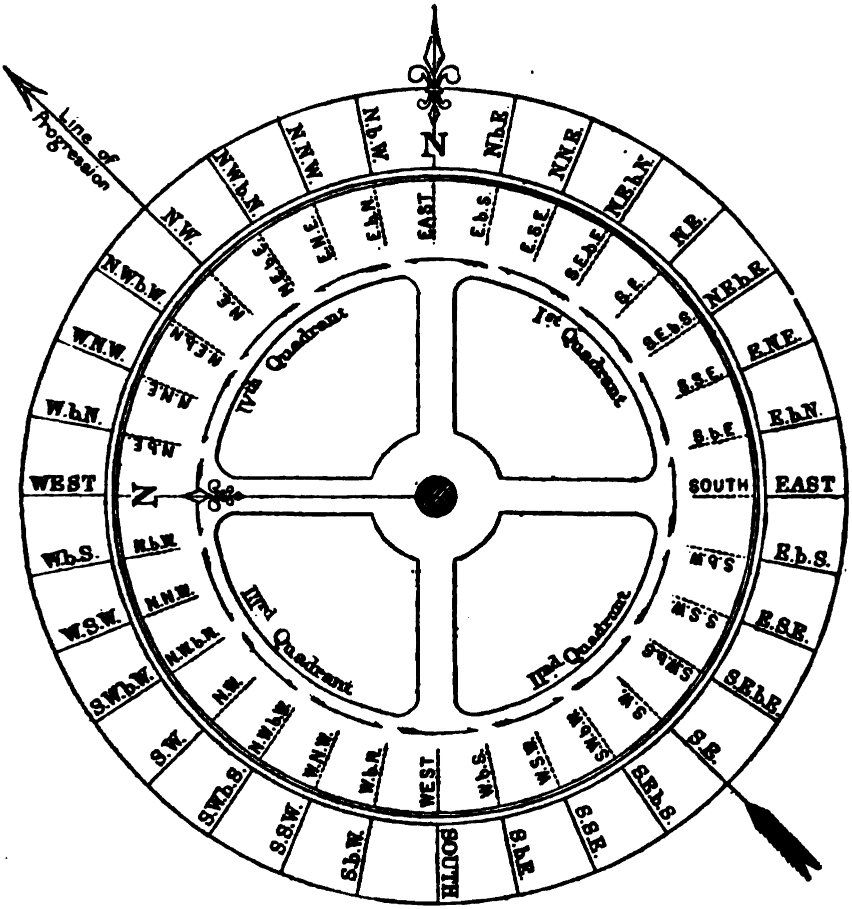
[*] "Journal of the Scottish Meteorological Society," 1888, pages 316—317.



The direction of the wind is almost independent of the progression of the Storm; and as the current of air sweeps round the centre in a more or less circular path, it follows that, under every point of the horizon, there will be experienced a wind blowing at an angle of eight points or more to it (158). Thus, were the Cyclone really circular (which seldom or never happens), under the *North* point of the horizon there will be an East wind; under the *South* point, a West wind; and under the *East* point, a South wind. So that, were the Storm stationary, a ship scudding round the entire circle, from any given position, would experience the wind from every point of the compass in regular succession; but this can very rarely, if ever, happen, on account of the progressive movement of the entire meteor.

As these Storms do not pursue a uniform velocity (226), the rate of their actual progression can be arrived at only after they have ceased to act on any two or more stationary spots, or upon two ships, by noting the exact time each experienced the first shock of the Hurricane, and also the time of its departure respectively. Some cause, or causes, operate to accelerate the rate at one time, and retard it at another.

It again becomes necessary here to observe that, although the general course of the Hurricane in the West Indies has been found to be N.W. or W.N.W., yet in two or three instances we have reason for believing that either a deviation in particular parts of its course, or a vibration or oscillation of the entire meteor, has taken place. Any deviation, however, from the general course pursued by these Storms can easily be detected, from the veering of the wind; as that ought to be regular, when the progressive path of the Storm is regular, except at or near the vortex. For instance, if the Hurricane commences at E.N.E., and the wind does not follow the regular successive changes, as noted above, we may be assured that the Storm is not pursuing a course to the N.W.; and the true line of progression may be ascertained by the circle, so as to gain the corresponding points of change to those which occur.

(175.) Again, if the Storm commences at North, the wind ought to veer (under the same progressive direction of N.W.) to the N.W., West, and end with it about W. by S. or W.S.W. But if, after the wind has got to West, the Storm should end with it at South (as it did at Antigua, 1804), we shall be assured that a deviation had taken place to the Westward in the progression, or otherwise a vibration or oscillation to the Southward.

The uncertainty of these aberrations should not deter the navigator from placing confidence in the general remarks here given, as these (based on Mr. Redfield's theory) have been arrived at from experience, from facts which are incontrovertible, and from a careful study of the subject; and besides, should these variations not happen, and to a certainty they do not always occur (at least on the ocean), he may benefit by them; whilst under a case of their occurrence, no rules can possibly be given for his guidance; he must place his vessel in the best position his judgment points out, and passively await the result.

As the Storm progresses into higher latitudes, the line of progression almost invariably changes to the North and N.E. (224), and then the sequence of the shifts of wind would naturally be different to what they are when the course of the Storm is W.N.W. or N.W., as will easily be seen by a reference to the illustrative diagrams.

We shall now endeavour to explain, in the plainest manner we can, the operation of the wind, and its effect on a vessel in each of the quadrants of the Storm, when the line of progression is to the N.W.

(176.) *First, or N.E. Quadrant.*—Wind from South to East. The changes of wind, *if a vessel be lying-to*, will *appear* to take place from *left to right*, throughout; as the wind will *seem* to draw round from the Eastward toward the South, although it is in fact proceeding the contrary way, or from right to left.

The navigator's attention is particularly directed to this apparent paradox; for, whilst he notes the wind down in his journal as veering with the sun, it is all the time, as remarked before, going the contrary way. The delusion is occasioned by the progression of the Hurricane to the N.W., which, by receding from the vessel's position, has the effect of bringing up the more Southerly *phases* of the wind in succession, and, consequently, imparting to these an *apparent* contrary direction to that which the whole current of air is actually pursuing. This deceptory process is somewhat similar to the well-known astronomical illusion every day before our eyes; we allude to the apparent course of the great luminary. Not only can we imagine, from the evidence of our sense of seeing (not at all times to be depended upon), that the sun is moving from East to West, but, in common *parlance*, such an idea is invariably expressed; yet everybody knows that this is only apparent, and that the delusion is occasioned by the diurnal rotation of the earth round its axis from West to East. This point, however, once clearly understood, will no longer perplex us.

We now proceed with the First Quadrant. If a ship scuds to the Northward, the direction of the alteration of the wind will in a great measure depend upon her velocity, as she is crossing the course of the progression obliquely; if she keeps pace with the *Northerly* advance of the Storm, the wind will remain the same; if she exceeds it, the wind will draw round to the Eastward; and if the progression outstrips her, the changes will be to the Southward. In either of the latter cases the variations will be few, in all probability; and the Westerly progress may be expected to cause the ship to be speedily thrown out of the circle of operations.

A ship is likely to enter this quadrant only under the Northern verge from the North to the N.E. point: if she happens to be standing to the Southward, within the limits of the Trade Wind, she will be liable to be taken aback; but if standing to the Northward, of course she will not.

(177.) *Second, or S.E. Quadrant.*—Wind from West to South. With a ship lying-to, and the wind from any point between South and S.W., the shifts will be from the Southward toward the West, *apparently* from *left to right*. If the wind be between S.W. and West, there will be few if any changes, as the ship will be near the posterior line of the progression; what changes may happen will probably be from West towards the South. The vessel will soon be clear of the commotion. It seems pretty evident that a sailing vessel will not, in the first instance, be liable to fall under the S.E. verge in this quadrant, for this reason—that she cannot overtake the Hurricane, as its velocity, in all probability, at any time would exceed her rate of sailing. She may, however, just touch laterally about the Southern verge, where she should get the wind from the West. To enter this quadrant, therefore, a ship must pass through some other.

(178.) *Third, or S.W. Quadrant.*—Wind from North to West. With a ship lying-to, with the wind from the Northward, as the Storm progresses it will draw round to the Westward, from *right* to *left*, truly as apparently so. As a ship scuds to the Southward and Eastward, the wind will draw round in the same manner as mentioned above. It appears obvious, that a vessel falling into the Storm, under any point in this quadrant, would merely feel the "*brush*" but she will be liable to be taken aback if standing to the Northward or North-Westward on first entering the scene of operation, supposing her to be within the limits of the Trade Wind.

(179.) *Fourth, or N.W. Quadrant.*—Wind from East to North. If a ship lies-to, with the wind at any point between East and N.E., it will *appear* to draw round from *left* to *right*, or from N.E. by E. to East. If she lies-to with the wind between N.E. and North, the shifts will be from *right* to *left*, or from N.E. by N. to North. Under the N.W. verge (where the wind is at N.E.), a ship, being then in the line of the anterior progression, will drift, probably, into or very near to the centre of the Storm, which, on account of the sudden shifting of the wind there (167), should, if possible, be avoided, as there the greatest danger may correctly be considered as existing.

If a ship scuds, under the same circumstances of winds, the changes will appear the same as above given; but slower in the first instance, and quicker in the second, for these reasons: that in the one case, the points of change are receding from her as she advances; and, in the other, they draw toward her approach, her velocity through the water accelerating the alterations; and this difference is occasioned by the progression of the Storm to the N.W.

Within the limits of the Trade Wind, if a ship be standing to the Southward, she will not be liable to be taken aback, on striking the Storm in this quadrant, but she would be so if steering to the Northward.

(180.) It should be constantly held in remembrance, that, under all circumstances, the wind remains the same; or, in other words, that under any given point of the horizon, the wind will be found to blow from a particular direction unchangeable, so that there is actually no shifting: the changes observable being occasioned by the progression of the Storm to the N.W., and the movements of the vessel.

From this peculiar character of the tempest, the course which a ship will pursue through the circle of operations, as also the successive changes of the wind, as these appear to take place, become an easy problem to solve, after having noted the point from which the first wind or the first shift, if felt (*provided* no divergency in the course, or vibratory motion of the meteor), takes place.

(181.) No general rules can be laid down for the guidance of the mariner for placing his ship in such a position as to ensure her not being taken aback when the Storm shall be first felt, because until that moment arrives, when the direction of the first blast is to become his "polar star," he cannot, with unerring certainty, anticipate his position with respect to the particular verge of the Hurricane that is approaching him.

Under such unavoidable circumstances, he must use his best judgment in preparation for meeting the worst, and be ready to lay his vessel to, or to scud, according to the direction of the wind first experienced. To be quite sure of what he is about to do, perhaps the safest plan would be to wait until the first *shift* takes place after the commencement of the Storm; by which measure his position would be confirmed, a point of material consequence to arrive at.

Every experienced seaman, after having given the theory his best attention, and made himself familiar with the whole working of the wonderful meteor, will of course follow the dictates of his own nature and judgment, upon an occasion that will assuredly call forth the full exercise of it. Without, therefore, presuming or desiring to obtrude upon him the manner we ourselves should act under a case of such uncertainty, which would demand all the resources of mind of the individual commander, for the first time placed in such a dilemma, we shall nevertheless offer it here as a mere illustration.

Let us, then, suppose that we are steering to the Northward in our ship, within the limits of the Trade Wind (call it E.N.E.), and that certain prognostics appear, which our judgment informs us forebode a Storm. If it happens to be the Hurricane season, we are bound by prudence to prepare the ship for encountering a tempest of that nature, even though appearances may induce us to think that such would not eventually happen; for, whether a mere common gale or a Hurricane should follow, every sensible person will admit that, during that season, it is the wisest as it is the safest plan, to be prepared to meet the worst that may happen under such appearances. It must be recollected that nature herself proclaims the warning, and her admonitions are not to be disregarded with impunity.

Without loss of time, we make the ship snug, hatches battened down, &c. This done, we should bring her to the wind on the starboard tack, with her head to the Northward, with a fore and a mizen storm stay-sail. We cannot, as we said before, anticipate under what verge of the Storm we shall enter, but we shall have done all that prudence can dictate, by lying-to *without square sails*, and of course making up our minds to have the fore-and-afters blown to shreds by the new wind, come from whatsoever quarter it may. In this position we must wait patiently until the first shift of wind takes place. If this should be from E.N.E. to E. by N. and East, we should make ourselves easy in the position obtained, with reference to the particular verge of the Storm, as well as in what we had placed the ship; having the assurance (from the shift of wind) that the anterior verge which had struck us would be now running away at the rate of from 15 to 20 miles an hour, whilst our drift to the Westward would not exceed 3½ miles in the same time; so that every point that the wind drew round toward the South would tell as plainly as if a map of the whole operations were suspended in the heavens overhead, for our consolation, that our exit from the commotion was rapidly drawing nearer and nearer; and that, if the ship proved equal to contend with the *crisis*, and no vibration occurred, we should escape the centre.

This may sound, in the style of the celebrated Francis Moore, of predicting memory, very like "taking a peep into futurity." We are not, however, studying the doctrine of probabilities. As far as we at present know of the matter, and (thanks to Mr. Redfield) we have gained a pretty general insight into it, there appear but two circumstances at all likely to upset our calculations and foresight of what is to happen, and these are, as intimated before, a divergency in the line of progression, or a vibration of the entire meteor; and here we are taught that, with all the wide and searching capacity of our minds, there is a point beyond which it is not permitted man to peer. We have been allowed, however, to glean enough of the economy of this wonderful phenomenon to excite our unfeigned gratitude to Him "who rules the whirlwind and the storm." We proceed—

On the other hand, if the shift of wind was to the N.E., or even a point on either side, we should immediately know that we were "in the very jaws of the lion;" and to escape being overwhelmed in the vortex, we must run for it.* On this occasion, every moment is of importance, when we bear in mind that we are now in the path which the centre will follow. To the S.W., therefore, we start away, not without an impressive dread, as the wind comes veering round and round toward North, of a too close approximation to the vortex, toward which the curve the ship makes inclines. If we could tell the exact diameter of the Hurricane, and its precise rate of progression, we could calculate pretty accurately whether, and at what distance, we should pass the centre; but as these data can never be obtained, we have nothing otherwise than *prudence* to guide us in this particular case, the most perilous that can occur.

There is a very nice point to be determined upon at this juncture, and one, although there will be but a few minutes for decision, that should not be rashly settled; a sort of choice between the scalping-knife and the tomahawk—a very forlorn hope, take which measure you please—it is this: whether to scud under square sail, or to run with bare poles? Now, however desirable it is that topsail should be carried in a storm (where the waves rise to a great height, and break in heavy surf, and a ship's way is lessened as she drops into the trough), to prevent her from being pooped, yet, we say, although it should be practicable to set a close-reefed main-topsail, the propriety of so doing is questionable until the wind has drawn round to the Westward of North (and then it might as well be left alone), for not before that will the dreaded centre have been passed; and as there can be no certainty of a ship's safety until that "consummation" has been accomplished, the chance of being taken aback with square sail deserves the most serious consideration of the commander. The danger in both cases is imminent; but, in determining for ourselves, we should run with bare poles, until finally thrown out of the Storm. Indeed, after all the judgment, care, anxiety, and apprehension which may be displayed and felt on so trying an occasion, our approximation, notwithstanding the vessel's *dash* of 12 or 13 knots, may be so near the vortex as that every stick shall be blown out of her. And we impressively declare our conviction, that hitherto the majority, if not all, of the vessels that have been lost in Hurricanes and Typhoons, have foundered by falling into the centre with square sail set whilst scudding. On lying-to, no sail would stand the disruptive puffs for five seconds!

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* When the line of progression is to the W.N.W. (a direction which some of the most Southern Storms have pursued), it would be wrong to scud with the wind at N.E.; but when at N.N.E., it would be proper to do so.

We have ourselves, in utter ignorance of the operations as they occur and are here stated, been scudding in a frigate, partly dismasted, with reefed *main-sail* (the only sail available), before the furious blast of a Hurricane, after the wind had veered to the S.W. As it happened, we had fortunately dropped into the second quadrant, and were drawing near our exit, but we knew nothing of that; and if it had happened in the fourth quadrant, and we had got into the centre, there is no doubt but that the ship must have foundered. But to proceed:—

No other resource is available to us under such circumstances as described above: and no other alternative remains except the desperate one of heaving-to, defying the fury of the Storm, and taking the chance of being thrown directly into the centre of commotion; where, if the ship do not founder, she would, there is scarcely a doubt, lose her masts, and be otherwise completely assailed at all points by the raging elements.

The N.W. verge of the Hurricane, whilst it advances in that direction, is the "very head and front" of the danger, the nucleus of which follows, in a direct line, the advance of that point. The consequences, be they the foundering of the ship, or the loss of her masts, &c., are inevitable, if prompt and active measures are not taken to get out of that position.

Should the wind, at first, keep steady at E.N.E. for some time, which it would do (if the storm is of great extent) when a ship enters under the N.N.W. verge, the navigator may be a little puzzled how to act, as anticipating a shift, to determine his position; he need be under no apprehension; the shift will come in due time (according to the extent of the circumference) from the E. by N., and so gradually round (but quickening as he approaches the centre) to the Southward: he may, however, expect to lose some of his spars when the *crisis* arrives.

We have dwelt longer upon the action of the wind in the fourth or N.W. quadrant, because under this anterior verge the greatest peril may follow; and we may now be permitted to express a hope that mariners may derive some little advantage from the perusal of this paper, as the writer has devoted his best attention to the subject with the sole view of rendering them, as brother sailors, a service. John Evans.

(182.) We will close this portion of our remarks with some general observations on the subject by *Captain Richard Leighton*, of Montrose, to whom we are indebted for numerous additions to hydrography:—

"1st. Outward-bound ships. As the S.E. storm-wind is generally nearly directly in front of the Storm, on meeting with that wind and a falling barometer, &c., you should bear off freely to the North-Westward, that is, nearly at right angles with the route of the gale, and all that you run that way will increase your distance from the centre when it passes you; whilst, if you run Westward, you will pass so near to the centre that you will be taken aback by the wind flying into the North-Westward; the object is to skirt the gale, and haul more Westerly as the wind veers to the Eastward.

"2nd. When the wind is to the Southward of S.E., it appears that you must pass through the right-hand semicircle, and should haul-to and hold all the southing that you can; lay down the bearing and distance of the centre, and as soon as practicable, by a second bearing and distance, estimate the route of the gale and its progress (168).

"3rd. Estimate your distance, and the course that you are likely to make, clear of leeway, and some veering in the wind, and this will give you an idea at what distance you are likely to pass the centre, and what is likely to occur. Knowledge is power. Most carry sail long enough, but many don't set it *soon enough*.

"4th. The farther the wind is to the Southward, the nearer you must pass to the centre, and as the wind veers and breaks her off, she will lay in the trough of the sea, and is most likely to get damage in that way, so that if the wind gets loose, it is time to be upon the right tack (that is, the starboard tack, with Westerly winds, in the Atlantic, being in the right-hand semicircle). Every one knows best what his own ship will bear, and what she will perform; however, if you *will go ahead* till the last minute, when the *barometer stops falling*, it is *high time* to have her round upon the right tack, as there is generally a tremendous gust shortly after the barometer stops falling, or when it has made a slight rise; and the ship should be upon the starboard tack, that she may *come up* and bow the sea when she takes it.

"5th. To wait for 'the lull,' or the 'sky to the Westward lighting up, to indicate the shift,' will often be *too late*."

(183.) We have given the above explanatory remarks of Lieutenant Evans and Captain Leighton in full, as they are still worthy of study. We now, however, proceed to give the results of the researches of the latest authorities on this subject, in as condensed and simple a form as possible.

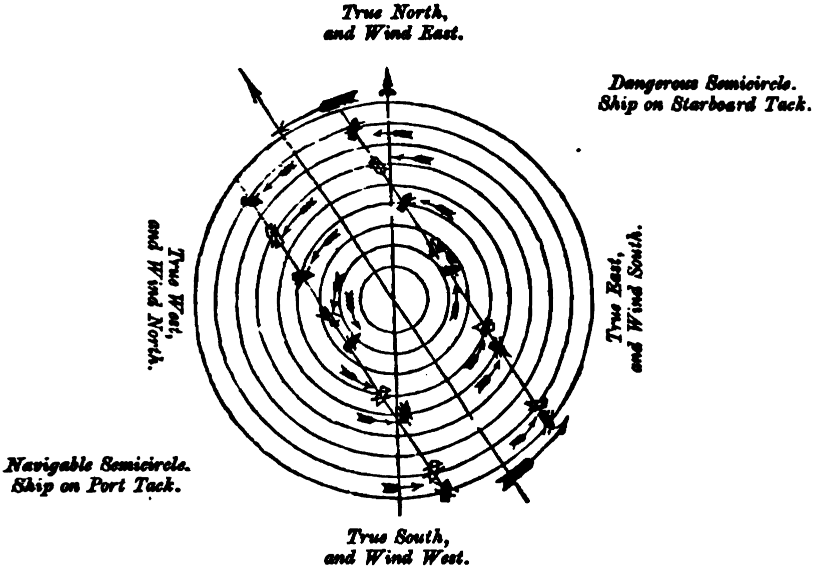
A Northward-bound vessel, after encountering a Hurricane in the Tropics, is liable to encounter the same Storm again in higher latitudes, after it has recurved. If, when lying-to, the Storm wind begins to shift in the opposite direction to what it did at first, it is evidence that the Storm track is recurving, and your semicircle is changed. Immediate action must be taken to suit the new conditions. If your vessel is making any great headway, it may give you a shift of wind contrary to what you would have if lying-to.

If on its approach the wind *veers*, or changes with the sun, through North, East, and South, the observer is on the right of the Storm track, and the centre will pass to the right of the direction in which it was first determined. When the wind *backs*, or changes through North, West, and South, the observer is on the left of the path, and the centre will move to the left of its first direction.

(184.) *Sir W. Reid's Rule for Laying Ships to in a Hurricane.*—That tack on which a ship should be laid-to in a Hurricane has hitherto been a problem to be solved, and is one which seamen have long considered important to have explained. In these tempests, when a vessel is lying-to, and the wind veers by the ship's head, she is in danger of getting stern-way, even when no sail is set; for in a Hurricane the wind's force upon the masts and yards alone will produce this effect should the wind veer ahead; and it is supposed that vessels have often foundered from this cause. When the wind veers aft, as it is called, or by the stern, this danger is avoided, and a ship then comes up to the wind, instead of having to break off from it.

If these great Storms obey fixed laws, and the explanation of them in this work be the true one, then the rule for laying a ship to follows like the corollary of a problem already solved. In order to define the two sides of a Storm, that side will be called the *Right-hand Semicircle* which is on the *right* of a Storm's course, as we look in the direction in which it is moving, just as we speak of the right bank of a river.

The Rule for laying a ship to will be :—*When in the Right-hand Semicircle to Heave-to on the Starboard Tack; and when in the Left-hand Semicircle to Heave-to on the Port Tack, in both hemispheres.*[*]


True North, and Wind East.
Dangerous Semicircle. Ship on Starboard Tack.
True West, and Wind North.
True East, and Wind South.
Navigable Semicircle. Ship on Port Tack.
True South, and Wind West.

In the above diagram, showing a typical Cyclonic Storm progressing to N.W. by N., in the direction of the great arrow drawn across it, the *black ships* are on their proper tack, the *white* ships being on the wrong. If we look at the black ships in the *left*-hand or navigable semicircle of the figure, it will be seen that they point with their heads to the Storm's centre. If they forge ahead, they will draw towards the Storm's central track.

(185.) **Rules for Action.**—1. Watch carefully for earliest indications, observing and *recording* observations of barometer, thermometer, wind, and weather, at frequent intervals, for reference. When the approach of a Hurricane is suspected, consider your latitude and the month, to decide your position with regard to the probable direction and recurve of the Storm (163).

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[*] "An attempt to Develop the Law of Storms," 3rd (last) edition, 1850, page 509; and "The Progress, &c., of the Law of Storms and of Variable Winds," 1849, page 25.

2. When a decided fall of the barometer, freshening rain squalls, and other unmistakable signs (166) indicate the close approach of the Cyclone, observe the shifts of wind very carefully to determine your position with regard to the Storm track. It is sometimes best to lie-to when thus observing the shifts of wind, or you may be led into serious error: a fast steamer may run into the dangerous semicircle of a slow-moving Cyclone, and yet get shifts of wind characteristic of the navigable semicircle.

3. If the freshening gale remain steady in direction, *you are in front of the track of the advancing Storm.* Square away at all hazards, and run with the wind on the starboard quarter, keeping your compass course as the wind shifts. If obliged to lie-to, do so on the port tack.

4. If the wind shift to the right, you are to the right of the Storm track, in the dangerous semicircle. Put the ship on the starboard tack, to head the ship away from the centre, and make as much headway as possible. If obliged to lie-to, do so on the starboard tack, and make all the headway you can.

5. If the wind shift to the left, you are to the left of the Storm track, and in the navigable semicircle. Bring the wind on the starboard quarter, and keep your compass course if possible. If obliged to lie-to, do so on the port tack, when the ship will head *towards* the centre, and should make as little headway as possible.

6. Any attempt *to cross the Storm track* is dangerous. If you decide it must be attempted, crowd sail and keep the wind well on the starboard quarter.

7. In scudding, always keep the wind well on the starboard quarter, in order to run out of the Storm. If obliged to lie-to, always do so on the coming-up tack, so that the wind will shift aft and not take you aback.

8. Should you get into the central calm of a Tropical Hurricane, look out for a terrific squall from a point of the compass almost exactly opposite to that from which the wind was blowing when it fell calm.

9. To prevent heavy seas breaking on board, use oil, about which more will be said later on.

(186.) *Meldrum's Brief Rules for Action.*—1. *If the squalls freshen without any shift of wind,* you are on or near the Storm track. Heave-to on the starboard tack, and watch for some indications of a shift, observing the low clouds particularly. If the barometer fall decidedly, say half an inch, without any shift, and if wind and sea permit, run off with the wind on the starboard quarter, and keep your compass course.

2. *If the wind shift to the right,* you are to the right of the Storm track, and in the dangerous semicircle. Put the ship on the starboard tack, and make as much headway as possible until obliged to lie-to, which do on the starboard tack.

3. *If the wind shift to the left,* you are to the left of the Storm track, and in the navigable semicircle. Bring the wind on the starboard quarter, and keep your compass course. If obliged to lie-to, do so on the port tack.

4. In scudding, always keep the wind well on the starboard quarter, in order to run out of the Storm.

5. Always lie-to on the coming-up tack.

Experience has shown that any attempt on the part of a sailing vessel

to cross in front of a Cyclone, and so get into the navigable semicircle, is fraught with the greatest danger, and should never be done except as a last resort.

(187.) **Practical Hints for the Benefit of Vessels leaving the Port of Havana, or Navigating in the West Indies, during the Hurricane Season.**—We cannot do better in closing this subject than to quote the excellent advice given by Padre Viñes, of Havana, translated from the pamphlet mentioned in the note on p. 225.—*(Nautical Magazine, November, 1885.)*

When there are Indications of a Hurricane to Windward:—

1. From Havana to the *Eastward*, navigation is very dangerous in August and September, but not so much so in October, as the Hurricanes then come in lower latitudes. In this last case, a sailing vessel should wait until the Hurricane has passed into the third quadrant, or bears somewhere between South and West, in order to take advantage of the winds from the S.E. shifting to South and S.W.

2. Navigation to the *Northward* is also very dangerous in this case. No sailing ship should try it, but a steamer can do so if sure to have time to get out of Florida Strait and away from the coast before the storm can reach her. If the captain resolves to do this he should go at full speed, to get clear of the strait and as far away as possible from the coast of Florida and the Gulf Stream, in order to have plenty of sea-room. He should do this from the moment he observes the first indications of the Hurricane, which may possibly be close upon him.

This is, without doubt, one of the regions of greatest danger, not only on account of the many storms which cross it with various directions and velocities, but also because in the bight between Cape Cañaveral and Cape Fear there is scarcely a manœuvre possible which is not dangerous.

In this part of the ocean it is preferable for a vessel to be in the *dangerous semicircle* of the storm, because at least there is always left the expedient of getting out by lying-to with the ship's head to the N.E., East, or S.E., as the occasion demands, while in the *navigable semicircle* the ship is squeezed between the track and the coast without space to run. Innumerable are the ships which in the last few years have been wrecked on this coast. If the steamer is going to Spain, by making an Easterly course South of the Bermudas after leaving the Strait, she soon leaves the zone where the storms occur. She will probably have headwinds at first, which will somewhat retard her voyage, and which would prevent a sailing vessel from following the course indicated.

3. Navigation to the *Westward* in the case supposed is scarcely attended with any danger, on account of the few Hurricanes which cross the Gulf of Mexico on the first branch of their track, and in case of curving well to the Southward they do not enter the Gulf very far. They give plenty of time, so that captains, being forewarned and having enough sea-room, can easily keep clear of the Hurricane in case of necessity.

If the Hurricane presents itself from the S.S.E. to South or S.W., or with Easterly winds shifting to the Southward:—

1. Navigation to the *Eastward* presents no danger.

2. The voyage to Vera Cruz and New Orleans may be very dangerous,

and the same may be said of navigation to the *Northward*, for these Hurricanes cross the Eastern portion of the Gulf and the Southern States with great velocity after curving, and frequently surprise ships which are sailing Westward, and reach those which a short time before left for the North.

When the Hurricane is to the North of Havana, or bears between West and North:—

1. Navigation to the *Eastward* is not only without danger, but also has the advantage of favourable winds.

2. Navigation to the *North* or to the *West* is also without danger if the Hurricane has already curved, because then the Storm travels faster than a ship and outstrips her rapidly. But if the Hurricane is curving, although navigation to the Westward is without danger in some cases, it will always be disadvantageous, because it is necessary to struggle against headwinds and heavy seas, wasting time, consuming coal uselessly, and straining the vessel without advancing much. To start North, this case presents no danger, but there may be danger in continuing in that direction. At all events the case is very simple, and if the captain has not intentionally put himself into the storm, or does not get in front of it, it is very certain that it will not seek him. It is evident, then, that he should not venture to pass Florida Strait in the storm, and leave the centre to the West or bearing between West and South, but rather wait until it has finished curving and disappears to the Northward, or between North and East.

(188.) Captains of vessels making the voyage from Spain to Cuba by way of Puerto Rico, from July to the end of October, on entering the zone of storms should keep a good look-out for the first indications of the Hurricane, in order not to be surprised and perhaps overwhelmed. This refers to storms in their first branch, distant from their origin and from the curve of their track, and which are violent, of short radius, and advance with great rapidity. If the first indications show that the bearing of the centre is South or S.W., by laying the ship to or slowing down, the storm will withdraw to the Westward or between West and North. If it appears between S.E. and South, it will not be prudent to go on, or at least it will be necessary to use much caution, moderating the speed as long as the storm does not move off to the S.W.

If the first indications show the centre to bear S.E., or S.E. by E., the ship is in a much more critical situation, perhaps in the track itself, and not very distant from the centre in the *dangerous semicircle*. She should be laid-to immediately, and allowed to reach N.E. as much as possible, utilizing for this purpose the diverging gusts of the first squalls even before the Cyclonic winds of the body of the storm are well established. If, during this manœuvre, it is seen that the centre moves towards the South, keep on lying-to, always on the starboard tack, luffing as the wind shifts to the right until it blows from the third or fourth quadrant.

If, having laid his ship to at the first indication of the storm, and it veers towards the first quadrant, the captain should see that the centre maintains the same bearing, that the barometer falls rapidly, and the wind increases in strength every moment, then the ship is in front of the track of the centre, or very close to it. Only in this extreme case, and when the captain is very certain of his observations, is it deemed prudent to bear up and risk running before the storm in order not to be overwhelmed. In performing this manœuvre, taking into consideration the convergence of the superficial or outer currents of the Cyclone, it is considered better judgment not to run directly before the wind, but to keep it always on the starboard quarter.

If the centre is first seen bearing E.S.E., or between East and E.S.E., it is probable that the ship is either in the track itself or in the navigable semicircle. To lie-to, in this case, would be a loss of precious time. It would be best, therefore, to run without losing a single moment, on a course between South and West, thus giving a chance for the Hurricane to withdraw in the direction of the first or fourth quadrant, or between East and West, through North.

Finally, if the Hurricane bears East, or E.N.E., run on a course between South and West, providing the wind freshens and the barometer falls. This case is almost free from danger, and presents no difficulties in manœuvring, as long as the ship is well away from the coast.

(189.) Ships bound from South America to Havana, in August and September, should go South of Cuba, entering the Caribbean Sea in the vicinity of Trinidad, and make their longitude without going much to the Northward before reaching the meridian of Cape San Antonio. If, while crossing the Caribbean Sea, they should have indications of a Hurricane to the Eastward, they should run immediately to the Southward as far as possible.

From the end of September to the beginning of November, on the contrary, the navigation of the Caribbean Sea is very dangerous, particularly in the vicinity of Cape San Antonio, while the voyage to the North of Cuba is less dangerous than during the preceding months. During October, ships should go well to the Eastward of the Windward Islands and to the North of Puerto Rico, and endeavour to make their latitude as soon as possible, as far as the parallel of 20°, between the meridians of 40° to 50°. Considering the track generally taken by Hurricanes in October, steamers starting for Spain during this month will go safer by way of Puerto Rico than to the Northward. Steamers from Cape San Antonio to Havana, in October, as soon as indications of a Hurricane are observed, if they are near Cape San Antonio, will do well to run for the Bank of Yucatan, and wait there, or else run out of their course to the Westward until the storm has passed, and take advantage of the favourable winds which follow it to continue their voyage.

If, on the first indications of a Hurricane, the ship finds herself between Cape San Antonio and Havana, the first thing to do is to get clear of the coast and the currents; when this done, if the centre bears between East and South, which is the most probable, continue running with the gale to W.S.W., and when the storm has passed to the N.E., the winds which follow it can be utilized to continue the voyage. If, when well away from the coast, the centre bears in the third quadrant, or between South and West, lie-to for some time, in order to observe if the centre remains on the same bearing, or veers towards the second quadrant. If either is the case, run immediately with the wind on the starboard quarter; but if it is seen that it veers to the Westward, the wind shifting to the right, lie-to with the head to the Eastward. This last case is exceedingly dangerous, and navigation in these waters should be avoided as much as possible during the month of October.

Knowing that occasions may arise when these observations will be of use, they are recorded here in the hope that they may prove of benefit in some emergency. The danger of navigating these waters is great, the difficulties many and often insuperable, the losses and shipwrecks all too frequent. If by means of these incomplete notes a single disaster should be averted, they will not have been written in vain.—*P. V.*

(190.) *The Storm-Wave*—the result of the Cyclone or Hurricane—and, perhaps, the greatest terror to seamen, almost always appears in the character of a *heavy cross-sea*, the period of which is irregular and uncertain. The disturbance within the area of the Cyclone is not confined to the air, but extends also to the Ocean, producing first a rolling swell, which eventually culminates in a tremendous pyramidal sea and a series of storm-waves, the undulations of which are propagated to an extraordinary distance behind, before, and on each side of the storm-field.*

(191.) **Oil on Rough Seas.**—In conclusion, as being intimately connected with the subject of Storms, we here call attention to the beneficial use of Oil in allaying the roughness of the sea, when applied in a proper manner. At the end of this work will be found a special article on this subject, with examples of its use by vessels in distress and otherwise.

(192.) **EXAMPLES.**—To illustrate the preceding remarks and directions, accounts of a series of Revolving Storms are given, illustrated by the diagram, before alluded to, at the commencement of this section.

Routes on the Chart.—No. I. Trinidad to Yucatan, over the middle of the Caribbean Sea; June 23 to 28, 1831.

No. II. Barbadoes to the Mississippi; August 10 to 17, 1831.

No. III. Guadaloupe to the Bank of Newfoundland; August 17 to 29, 1827.

No. IV. Guadaloupe and Antigua to Charleston, and thence to the Bay of Fundy; September 3 to 10, 1804.

No. V. Antigua, passing over Cuba, to the coast of Texas; August 12 to 18, 1835.

No. VI. Barbuda to Charleston, and thence to the Bank of Newfoundland; August 12 to 19, 1830.

No. VII. From the intersection of lat. 20° N. and long. 60° W. (N.E. of Barbuda), passing to the West of Bermuda, and thence N.E. to the parallel of 42½°; September 29 to October 2, 1830.

No. VIII. From the parallel of 22° (North of Porto Rico) to Cape Hatteras and the coast of Maine; September 1 to 5, 1821.

No. IX. From near the same spot as No. VIII., on a similar route, but more to the Eastward; August 22 to 27, 1830.

No. X. From the parallel of 30° N., on the East side of the Gulf Stream, to Cape Sable of Nova Scotia; January 13 to 16, 1831.

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* "Remarks on Waves," in the Nautical Magazine, September, 1887, page 759.

No. XI. Inland Storm, over the Lakes, and thence to the Gulf of St. Lawrence; November 10 to 12, 1835.

No. XII. From near the meridian of 50° W. to the Northern part of Cuba, thence progressing to the *South of West* to Vera Cruz; August 30 to September 7, 1888.

No. XIII. From Martinique to Porto Rico, Turks Islands, and the Southern part of Florida; August 18 to 25, 1891.

No. XIV. From 21° N. and 47° W. to Bermuda, and thence to the Eastward; September 16 to 26, 1891.

No. XV. From near 39° N. and 51° W. to the North-Eastward and then Northward; June 8 to 10, 1891.

No. XVI. From 23½° N. and 57° W. to 20° N. and 60° W., and then recurving to the Northward, passing over Newfoundland; August 15 to 23, 1892.

The route designated as No. I. is that of the Hurricane which visited the Islands of Trinidad, Tobago, and Grenada, on June 23rd, 1831. Pursuing its course through the Caribbean Sea, it was subsequently encountered by H.M. schooner *Minx*, and other vessels, and its swell was thrown with great force upon the South-Eastern shores of Jamaica on the 25th, while passing that island, where the wind at this time was light from the Northward. After sweeping through the Caribbean Sea, the Hurricane entered upon the coast of Yucatan, on the night of the 27th, having moved over the entire route from Trinidad to the Western shore of the Bay of Honduras, in a little more than 100 hours, a distance of nearly 1,700 miles, equal to 17 miles an hour.

Track No. II. is that of the Hurricane which desolated Barbadoes in the night of August 10th, 1831; and which passed Porto Rico on the 12th; Aux Cayes, in Hayti, and S. Iago de Cuba, on the 13th; Matanzas on the 14th; was encountered off the Tortugas on the 15th; in the Mexican Sea on the 16th; and was at Mobile, Pensacola, and New Orleans, on the 17th; a distance of 2,000 miles in about 150 hours, exceeding 13¼ miles an hour. Its course, until it crossed the Tropic of Cancer, was nearly W.N.W. Mr. Redfield adds—"In pursuing its Northern course, after leaving the ocean level, it must have encountered the mountain region of the Alleghanies, and was perhaps disorganized by the resistance opposed by these elevations. It appears, however, to have caused heavy rains in a large extent of country North-Eastward of the Mexican Sea."

Track No. III. is that of the destructive Hurricane which swept over the Windward Islands, August 17th, 1827; visited St. Martin and St. Thomas on the 18th; passed the N.E. coast of Hayti on the 19th; Turks Islands on the 20th; the Bahamas on the 21st and 22nd; was encountered on the coast of Florida and South Carolina on the 23rd and 24th; off Cape Hatteras on the 25th; off the Delaware on the 26th; off Nantucket on the 27th; and off Sable Isle and Bank on the 28th. Its ascertained course and progress were nearly 3,000 miles in about eleven days; or at the average rate of about 11 miles an hour. The direction of its route, before crossing the Tropic, nearly N. 61° W., and in lat. 40°, while moving Eastward, N. 58° E.

Track No. IV. The extensive Hurricane of September, 1804, which swept over the Windward Islands on the 3rd of that month; the Virgin Islands and Porto Rico on the 4th; Turks Islands on the 5th; the Bahamas and the Strait of Florida on the 6th; the coast of Georgia and the Carolinas on the 7th; Chesapeake and Delaware, with the contiguous portions of Virginia, Maryland, and New Jersey, on the 8th; and the States of Massachusetts, New Hampshire, and Maine, on the

9th; being on the high lands of New Hampshire a violent snow-storm. The destructive action of this storm was widely extended on both sides of the track indicated upon the chart, and the same fact pertains in a greater or less degree to the other storms herein mentioned. It appears to have passed from Martinique and the other Windward Islands to Boston, by the usual curvilinear route, in about six days, a distance of more than 2,200 miles, at an average progress of about 15¼ miles an hour.

Track No. V. The route of the Hurricane which ravaged Antigua, Nevis, and St. Kitt's, in the afternoon and night of August 12th, 1835; St. Thomas, St. Croix, and Porto Rico, on the 13th; Hayti and Turks Islands on the 14th; the vicinity of Matanzas and Havana on the 15th; was encountered off the Tortugas, on the Bank of Florida, on the 16th; in lat. 27° 21′, long. 94°, and other points, on the 17th and 18th; and at Matamoras, near the Mexican shore, lat. 26° 4′, on the 18th, where it was most violent during the succeeding night. It also passed over Galveston Bay, in Texas, and there blew with violence from the S.E.; while at the mouths of the Mississippi and along the Northern shores of the gulf, the gale was not felt. This storm is remarkable, as moving more directly and farther to the West than is usual for storms which pass near the West Indian Islands, it having reached the Mexican shores before commencing its sweep to the Northward. Course about N. 78° W.; progress more than 2,200 miles in six days; nearly equal to 15¼ miles an hour.

Track No. VI. The memorable gale of August, 1830, described hereafter, which, passing close by the Windward Islands, visited St. Thomas on the 12th, was near Turks Islands on the 13th; at the Bahamas on the 14th; Eastern coast of Florida on the 15th; coasts of Georgia and the Carolinas on the 16th; off Virginia, Maryland, New Jersey, and New York, on the 17th; off George's Bank and Cape Sable on the 18th; and over the Newfoundland Bank on the 19th; having occupied about seven days in its ascertained course from near the Windward Islands, a distance of more than 3,000 miles; the rate of its progress being equal to 18 miles an hour. If, adds Mr. Redfield, we suppose the actual velocity of the wind, in its rotatory movement, to be five times greater than this rate of progress, which is not beyond the known velocity of such winds, it will be found equal, in this period, to a rectilinear course of 15,000 miles. The same remark applies, in substance, to all the storms which are now passing under review.

Track No. VII. This storm was encountered to the Northward of the Caribbee Islands on September 22nd, 1830; its route was to the Eastward of all those previously described, and was found on the Grand Bank of Newfoundland, October 2nd, having caused great damage and destruction, on its widely-extended track, to the many vessels which fell in its way. The ascertained route may be estimated at 1,800 miles, and the average progress 25 miles an hour.

Track No. VIII. Experienced in September, 1821, as more fully shown hereafter, this Hurricane was extremely violent: it was encountered to the North-Eastward of Turks Islands, on the 1st of the month; to the Northward of the Bahamas and near the latitude of 30° on the 2nd; on the coast of the Carolinas early in the morning of the 3rd; and from thence, in the course of that day, along the coast of New York and Long Island; and it is represented to have continued its course across the States of Connecticut, Massachusetts, New Hampshire, and Maine. The diameter of the storm appears to have exceeded 100 miles; its ascertained route and progress about 1,800 miles in sixty hours, equal to 30 miles an hour.

A similar but less violent storm swept along the same portion of the coast of the United States on April 28th, 1835.

Track No. IX. The route of a violent and extensive Hurricane, which was encountered to the Northward of Turks Islands, August 22nd, 1830; Northward of the Bahamas on the 23rd; and off the coast of the United States on the 24th, 25th, and 26th of the same month. It produced much damage, but scarcely reached the American shores. Its duration was about forty hours, and progress more tardy than some others.

Track No. X. A violent Hurricane and snow-storm, which swept along the American coast from the parallel of 30° N., on December 5th and 6th, 1830. This track corresponds to another storm of similar character, which swept along the coast on the 13th, 14th, and 15th of January, 1831. These violent winter storms exhibited nearly the same phases of wind and general characteristics as those which appear in the summer and autumn.

Track No. XI. The violent inland storm which passed over the Lakes Erie and Ontario on November 11th, 1835. This storm was very extensive, spreading from the sea-coast of Virginia into the Canadas, to a limit unknown. The anterior portion of this gale was but moderately felt, and its access was noted chiefly by the direction of the wind and the great fall of the barometer; the violence of the storm being exhibited chiefly by the posterior and colder portion of the gale, as is common with extensive overland storms. The regular progression of the storm, in an Easterly direction, was established by facts collected by Mr. Redfield, from the borders of Lake Michigan to the Gulf of St. Lawrence and the coasts of New England and Nova Scotia.

In pursuing the descriptions above, it is to be noted that the lines on the chart, representing the routes, are given by Mr. Redfield as but approximations to the centre of the track or course of the several storms; and the gales are to be considered as extending their rotative circuit from 50 to 300 miles or more, on each side of the delineations; the superficial extent of the storm being estimated both by actual information and by its duration at any point near the central portion of its route, as compared with its average rate of progress.

The circular figure which appears upon the chart, on Tracks Nos. I., V., and VII., will serve, in some degree, to illustrate the course of the wind in the various portions of the superficies covered by the storm, and also to explain the changes in the direction of the wind, which occur successively at various points, during the regular progress of the gale.

(193.) The tracks and descriptions of these storms, which occurred so many years ago, are still reliable and typical of those encountered in more recent years. We therefore let them remain, only giving here some more modern instances of irregularity in their phenomena.

Track No. XII. On September 4th and 5th, 1888, the Northern part of Cuba was devastated by one of the most destructive Hurricanes recorded. It originated in the N.E. Trade Wind belt, Eastward of the meridian of 60°, on August 30th and 31st. On September 1st, its centre was near lat. 20° N., long. 60° W., moving to W. by N. at about 16 miles an hour. Thence it passed Northward of San Domingo, and on the night of September 3rd it struck the Cuban coast near Sagua La Grande with devastating force. Continuing its course, it passed over the island, to the Southward of Havana, and then developed a most remarkable feature, changing its course to the *South of West.* After leaving the West end of Cuba on the 5th, it took a W.S.W. direction, skirting the North coast of Yucatan, and reached Vera Cruz on the 7th, where it did much damage to the shipping.

In connection with this Storm, it is reported that the master of the Spanish mail steamer *Cataluna*, about to sail from Puerto Rico for Havana, seeing unmistakable signs of an approaching Hurricane, quickened his departure and put his vessel on her course at full speed, keeping the North wind as nearly abeam as possible, and arrived at his destination in advance of the Hurricane, which had not gained a mile on him. This action, though very risky, is mentioned in order to show how a skilful navigator, thoroughly understanding the Law of Storms, may not only escape them, but may avail himself of their strong winds to assist him on his passage.

Track No. XIII. On August 18th, 1891, a most destructive Hurricane was experienced at Martinique, of which further particulars are given later on. This storm took a somewhat irregular course, crossing over Porto Rico, the Caicos, Crooked Island, and lower Florida, finally dying out in the N.E. part of the Gulf. This unusual course, and its failure to recurve, are remarkable, probably owing to areas of high pressure to the Northward.

Track No. XIV. shows the course of a Hurricane which passed near Bermuda, September 21st, 1891. Here, after recurving, it bore rapidly away to the Eastward.

Track No. XV. shows the abnormal course of a Hurricane which passed about 500 miles East of Newfoundland on June 9th and 10th, 1891. This was probably due to an Anti-Cyclonic area of high pressure lying to the Eastward.

Track No. XVI. shows the unusual track of a Hurricane experienced in the Tropics, between August 15th and 19th, 1892. Observations seem to indicate that it moved in a *South-Westerly* direction towards St. Thomas, before following the track usually taken by these storms in the Tropics. This Hurricane was of small area, but most violent in energy.

(194.) *The Great Hurricane*, which commenced at Barbadoes on *October* 10*th*, 1780,[*] was preceded in the evening of the 9th by weather remarkably calm, but the sky surprisingly red and fiery, and during the night much rain fell. The storm approached from the S.E., and the ships of the squadron stationed here experienced the Hurricane, each in turn, according to the place she was in. A letter from Dr. Blane, dated from the *Sandwich*, Sir George Rodney's flagship, stated that it was not previously apprehended that there would be anything more than such a gale as they experience from time to time at that season; but, on the evening of the 10th, the wind rose to such a degree of violence as clearly to amount to what is called a *Hurricane*. At 8 p.m. it began to make an impression on all the houses, by tearing off the roofs, and overthrowing some of the walls. As the inhabitants had never been accustomed to such a convulsion of nature, they remained for some time in security, but they now began to be in the utmost consternation. * * * * It was thought to be at its greatest height at midnight, and did not abate considerably until eight next morning. During all this time, most of the inhabitants had deserted their houses, to avoid being buried in the ruins; and every age, sex, and condition, were exposed in the fields to the impetuous wind, incessant torrents of rain, and the terrors of thunder and lightning. Many were overwhelmed in the ruins, either by clinging for shelter too long in the buildings, or attempting to save what was valuable, or by unavoidable accidents in the fall of walls, roofs, and furniture, the materials of which were projected to great distances. Even the bodies of men and cattle were lifted off and carried above the ground. From an estimate of the number of deaths reported to the governor, they amounted to more than 3,000. All the fruits of the earth were destroyed: most of the trees torn up by the roots, and many of them stripped of their bark. The sea rose so high as to destroy the fort, carrying the great guns many yards from the platform, and demolishing the houses near the beach. A ship was driven on shore against one of the buildings of the naval hospital, which, by this shock, and by the impetuosity of the wind and sea, was entirely destroyed and swept away. * * * * The mole-head was swept away; and ridges of coral rock were thrown up to above the surface of the water; but the harbour and roadstead were, upon the whole, improved, having deepened in some places 6 feet, in others many fathoms. The crust of coral, which had been the work of ages, was broken up, leaving a soft oasy bottom, and many shells and fish were found ashore, which had been previously unknown.

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[*] The track of this Hurricane is shown on the Chart, commencing between Nos. i. and ii.

The Hurricane passed, in succession, over the Islands of St. Vincent, St. Lucia, Martinique, and Dominica, and included within its area those of Guadaloupe, St. Christopher, St. Eustatius, &c. At St. Vincent, every building was blown down, and the town destroyed. At St. Lucia, which was near the centre of the Hurricane, all the barracks and other buildings were blown down and the ships driven to sea. At Martinique, likewise, all the ships that had brought troops and provisions were blown off the island. On the 12th, four ships with their crews foundered in Fort Royal Bay. The other ships were blown out of the roads. In the town of St. Pierre, on the N.W. coast, every house was blown down, and more than 1,000 people perished. At Fort Royal, the cathedral, seven churches, other religious edifices, many public buildings and 1,000 houses, were blown down, as well as the hospital of Notre Dame, in which were 1,600 sick and wounded, the greater part of whom were buried in the ruins. The number of persons who perished in Martinique is said to have been 9,000. Dominica likewise suffered greatly, and Guadaloupe was within the Northern verge of the Hurricane.

At *St. Eustatius*, although not far within the N.E. verge, the loss was very great. On the 10th of October, at 11 a.m., the sky on a sudden blackened all round; it looked as dismal as night, attended with the most violent rains, thunder, lightning, and wind. In the afternoon the gale increased; seven ships were driven on shore near the North point, dashed to pieces on the rocks, and their crews perished. Nineteen vessels cut their cables and went to sea. In the night every house to the Northward and Southward was blown down, or washed away with the inhabitants into the sea, a few only escaping. The houses to the East and West were not so much hurt till the afternoon of the 11th, when the wind, on a sudden, shifted to the Eastward; and at night it blew with redoubled fury, and swept away every house; but the forts, barracks, hospital, cathedral, and four churches remained. Here between 4,000 and 5,000 persons are supposed to have lost their lives.

Advancing North-Westward, the centre of the Hurricane on the 14th had reached to the Mona Passage, on the West of Porto Rico. Here the *Ulysses* and *Pomona*, with a fleet under their convoy, suffered greatly, and here the *Deal Castle* frigate was wrecked. Another frigate, the *Diamond*, fell within the Western verge of the storm on the 15th, but happily escaped by passing Alta Vela, on the South side of Haiti. Above the parallel of 20°, the *Stirling Castle* was lost on Silver Kay Bank, and most of her crew perished. On the 18th we find, in about 22½° N., and 69° W., the *Trident*, *Ruby*, *Bristol*, *Hector*, and *Grafton*, men-of-war, on the S.W. verge of the storm. The ship last-mentioned, on the 16th, at noon, was in lat. 26½°, long. (by estimation) 71° 30′; heavy gales and cloudy weather; lying-to under trysails; the gales split the sails to ribands. On the 18th, lying-to; strong gales and heavy squalls.—17th to 18th, carried rapidly to the South-Eastward, when the *Trident*, *Ruby*, and *Hector*, came in sight as above; at 11 a.m., spoke the latter, in great distress.

The *Ruby*, *Trident*, and *Bristol* on the 15th, were as high as 27½° N., and they, too, from the Western border of the Hurricane, were driven to the Southward, until they joined company.

Here the detail becomes imperfect, until we reach the Bermudas; but to the N.E. of these isles we find the *Berwick*, on the 19th, which had fallen, on the 17th, within the border of the Hurricane from a position to the W.N.W., near the latitude of 35°. This ship had previously been one of Rear-Admiral Rowley's squadron; she was proceeding to England under jury-masts, and had reached to the North of the latitude of the Bermudas, when the Hurricane overtook her. On the 16th, at 11 a.m., during calm, there was a great swell from the Eastward. On the 17th, at 1 p.m., she was taken aback; wore ship and handed topsails; at 3, squally, with rain; loosed the topsails; 6 to 8 p.m., wind E. by N., fresh gales. On the 18th, winds variable from the Eastward, E. by N. to E.S.E.; after midnight, strong gales and heavy squalls. At noon, by estimation, Bermudas S. 53° E., 93 miles. 19th, at 1 a.m., weather moderate, and the ship proceeded on her course.

On the 18th, about fifty vessels were driven on shore at Bermuda.

We have been the more particular in giving these details, from having formerly been misled by imperfect data. In the delineation of the "Great Hurricane," given by Colonel Reid, he first assumes a circle having a radius of about 170 miles, which gradually expands, on its N.W., North, and N.E. course, to 270 miles, with, we may presume, a diminished and proportionate momentum, on the parallel of Bermuda. The colonel observes that, on reading the logs and the various accounts of this Hurricane, and comparing the different reports of the wind, it will be found that no storm yet described, proves more strongly than this, the rotatory nature of Hurricanes.

(195.) *Trinidad, June*, 1831.—(*No. I. on the Chart.*)—On June 23rd, 1831, Trinidad, in the parallel of 10½° N., experienced one of the most awful storms of wind and rain ever remembered by the oldest inhabitant. The gale commenced at 5 o'clock on Thursday morning, and continued till 11. The wind, after shifting from East, North, West, and South, finally settled at S.W., and blew without intermission until 8 in the afternoon. Eleven or twelve vessels were driven on shore, and several of them severely damaged.

It was subsequently stated that the Hurricane was felt at all the Southern islands, where the loss it occasioned was very great. Such a storm had not happened at Grenada since the year 1780; the devastation was extensive and dreadful; and the loss in that colony was estimated at £80,000. Its course to Yucatan is described hereafter.

(196.) *Barbadoes, August*, 1831.—(*No. II. on the Chart.*)—In the night following August 10th, one of the most devastating Hurricanes that had ever been experienced visited Barbadoes. Not a single house was left uninjured, and the greater part were levelled with the ground. On the 11th it passed over the Islands of St. Vincent and St. Lucia, extending a portion of its influence to Martinique and islands to the N.W., and to Grenada on the South, but exhibiting its principal violence between 12¾° and 14° N., or the parallels of Barbadoes and Martinique. On the 12th it arrived on the Southern coast of Porto Rico; from the 12th to the 13th it swept over the South side of Hayti, and extended its influence as far Southward as Jamaica. On the 13th it raged on the Eastern portion of Cuba, sweeping in its course over large districts. The town of Aux Cayes, in Hayti, was almost destroyed by its force, and that of St. Iago de Cuba was very much damaged. On the 14th it was at Havana and toward the West end of Cuba. On the 15th it proceeded North-Westward, and on the 16th and 17th it arrived on the Northern shores of the Mexican Sea, in about the 30th degree of latitude, raging simultaneously at Pensacola, Mobile, and New Orleans, where its effects were continued till the 18th. At New Orleans, on the 17th, it came on in dreadful gales, from N.E. to S.E., accompanied with torrents of rain. Almost all the shipping in the river were driven on shore, and very few of the smaller craft escaped total wreck. The back part of the city was completely inundated. The sugar-canes, above and below the city, were laid flat, and the loss was enormous. The gale was felt at Natchez, 300 miles up the river; and hereabout it spent itself in heavy rains, after having occupied a period of six days in the cycloidal course from Barbadoes.

At most of the islands, during the Hurricane, the winds in the earlier part of the storm were from a Northern quarter, and in its later periods from a Southern quarter, of the horizon; from which it results, that the gyratory action was from *right* to *left*, as in the storms which pass to the Northward of the great islands, and along the Western coast of the ocean.

The distance passed over by the storm, in its passage from Barbadoes to New

Orleans, is equal to 2,100 nautic miles. The average rate of progress about 14 miles an hour.

(197.) *Hurricane of* 1830.—The storm which passed the city of New York, on *August* 17*th*, 1830, was there, and along all the coast Northward of Cape Hatteras, considered as a *North-East storm*.—(*See Chart, Route VII.*)

It appears that this storm commenced at the Island of St. Thomas, on the night between the 12th and 13th of August. On its progress, in the afternoon of the 14th, it commenced at the Bahama Islands, and continued during the succeeding night, the wind almost round the compass during the existence of the storm. On the 15th, in the Florida Channel, its effects were very disastrous. Without the strait, in lat. 26° 51′, long. 79° 40′, the gale was severe from N.N.E. to S.W. Late on the same day, off St. Augustin, it was equally so. At 20 miles North of St. Mary's, from 8 p.m. on the 15th, to 2 a.m. on the 16th, it was from an Eastern quarter, then changed to S.W.

Off Tybee and at Savanna, on the night of the 15th, it changed to N.W. at 9 a.m., on the 16th, and blew till 12. On the 18th, at Charleston, the gale was from S.E. and East, till 4 p.m.; then N.E. and round to N.W. At Wilmington (North Carolina) the storm was from the East, and veered subsequently to the West. In the vicinity of Cape Hatteras, at sea, the storm was very heavy from S.E., and shifted to N.W.

Early in the morning of the 17th, the gale was felt severely in the Chesapeake, from the N.E. Off the Capes of Virginia, on the 17th, lat. 36° 20′, long. 74° 2′, "a perfect hurricane," from South to S.S.E., from 5 a.m. to 2 p.m., then shifted to N.W.

Off Cape May, lat. 32°, long. 74° 15′, in the afternoon of the 17th, a heavy gale from E.N.E. Coast of New Jersey, same afternoon, heavy at N.E. Again, in lat. 39°, long. 73°, at E.N.E. In the same latitude, long. 70° 30′, a "tremendous gale," commencing at S.S.E., and veering to North.

Afternoon and evening of the 17th, at New York and in Long Island Sound, gale at N.N.E. and N.E. Off Nantucket Shoals, at 8 p.m., severe at N.E. by E. In the night of the 17th, off Nantucket, and in the Gulf Stream, lat. 38° 15′ long. 67° 30′, "tremendous," commencing at South, and veering, with increasing severity, to S.W., West, and N.W. Peninsula of Cape Cod, in the night between the 17th and 18th, severe at N.E.; 18th, at Salem and Newbury, heavy gale from N.E. In lat. 39° 51′, long. 69°, severe from S.E., suddenly shifting to North. In lat. 41° 20′, long. 60° 25′, "tremendous hurricane" from N.N.E.

Off Sable Island, in the night of the 18th, lat. 48°, long. 59½°, "tremendous heavy gale," from South and S.W. to West and N.W. In lat. 48°, long. 48°, a severe gale from the South; the manner of change not reported.

This remarkable storm appears to have passed over the whole route above described in about six days, at an average of about 16 miles an hour; the duration of its most violent portion, at the several points over which it passed, may be stated at from 7 to 12 hours; and the width of its track is supposed to have been from 150 to 200 miles.

"On the Western part of the Atlantic Ocean, between the parallel of New York and the Northern limit of the Trade Wind, the prevailing winds, for a considerable period, both previously and subsequently to the occurrence of this storm, were South-Westerly, or from the Southern quarter; and over the whole breadth of the Atlantic, on the route frequented by ships in the European trade, fresh South-Westerly or Westerly winds also prevailed at the same period, for many weeks. These facts are well established by numerous marine journals, which have been consulted in relation to this subject."

Of the vorticular or rotative character of the storm, striking evidence was afforded by the journals of two ships, the *Britannia* and the *Illinois*, both bound from America to Europe; the particulars of which are fully given by Mr. Redfield.

(198.) *In about a week after the storm last described*, another occurred, which passed New York on the 26th and 27th of August, and which was, also, on this coast, a N.E. storm, of about three days duration. From the Eastward of the Bahamas it appears to have passed Northwardly between the Florida Stream and the Bermudas; and touching the American shore near Cape Hatteras, raged with great fury for about forty hours at each locality, as it swept the great central curve of the coast; and passing from thence, continued its course over George's Bank, in a North-Easterly direction. It was evidently of greater compass, and slower progress, than the preceding storm, as proved by a collation of the various reports of mariners; and its long duration, and its effects were almost equally violent.

The next remarkable series of Hurricanes appear to have originated in the vicinity of the Windward Islands, near the close of September, 1830, and which, passing Westward of the Bermudas, on a course nearly North, assumed thence a more Easterly course, toward the Southern edge of the Grand Bank of Newfoundland.—(*See the Chart, Route VII.*)

This storm was very disastrous. In lat. 20½°, long. 68°, it commenced, on September 22nd, at 1 p.m., and continued till 6^h 30^m p.m., from N.E. and S.W. alternately. On the same day it passed through lat. 22° 46', long. 65°. At night, on the 30th, in lat. 26° 7', long. 66½°, "very heavy," for five hours and a half. On the 1st of October it arrived at lat. 30° 38', long. 68°; severe at S E., shifted to N.W.; thence it was found in lat. 33°, long. 66½°; lat. 34° 9', long. 66° 12'; lat. 35°, long. 68°; lat. 38°, long. 63°; lat. 38½°, long. 57°; lat. 40°, long. 61°; lat. 40° 25', long. 58° 24'; lat. 41°, long. 55°, and very severe. By an average estimate of rates and distances, it appears to have proceeded at the rate of about 27 miles an hour.

The extensive Hurricane of 1804, which swept over most of the Windward Islands in the West Indies, commenced at Martinique, on the 3rd of September, reached Savanna on the 7th, Boston on the 9th, and became a *snow-storm* on its arrival in the interior of New Hampshire.

The great gale of 1815 commenced at St. Bartholomew's on the 11th of September, and reached Rhode Island on the morning of the 23rd, where it was awfully destructive from the S.E., while in the South-Eastern parts of Massachusetts, it was then blowing at South; at New London, from East to S.E.; and at New York, from North to N.N.W.

(199.) *A S.E. storm in September*, 1821—(*see Chart, Track VIII.*)—was experienced in the central parts of Connecticut, commenced blowing violently from E.S.E. and S.E., at about 6 p.m. on the 3rd of September, having been preceded by a fresh wind from the Southern quarter, and flying clouds. It continued blowing in heavy gusts, and with increasing fury, till about 10 p.m., when the wind suddenly subsided. A calm or *lull*, of perhaps fifteen minutes duration, ensued, but was terminated by a violent gust from the N.W., which continued till about 11 p.m., and then gradually abated. Much damage was sustained, and fruit-trees, corn, &c., were uniformly prostrated toward the N.W.

At New York the same storm was experienced, with at least equal violence, about three hours earlier than in Connecticut, but blowing from a more Eastern quarter. In the North-Eastern parts of Massachusetts it was experienced some hours later; and at Providence, in Rhode Island, the storm was felt in the South-Eastern quarter, but not severely; as was also the case in the South-Eastern parts of Connecticut. In the N.W. portions of the latter state, and the adjacent towns of Massachusetts, the gale blew with its chief violence from the N.W. quarter, and the trees and corn were uniformly prostrated toward the S.E.

At New York the gale was from N.E. to East, and commenced blowing with violence at 5 p.m., continued with great fury for three hours, and then changed to West. More damage was sustained in two hours than was ever before witnessed in the city, the wind increasing during the afternoon, and *at sunset was a Hurricane.* At the time of *low water* the wharfs were overflowed, the water having risen 13 feet in an hour. Previous to the setting in of the gale, the wind was from South to S.E., but changed to the N.E. at the commencement of the storm, and blew with great fury till evening, and then shifted to the Westward.

(200.) *The Cyclone of August*, 1870,* took the following course. The calm centre passed Antigua on August 21, at 6h 40m a.m.; St. Kitt's, at 9h a.m.; St. Eustatius, at noon; St. Thomas, at 5h 15m p.m.; Turks Island, August 22, at midnight; Long Island, August 23, at 5h 30m p.m.; Great Exuma, at 8h 30m p.m.; Nassau, August 24, at 4h 30m p.m.; and reached the vicinity of Key West, about 8h p.m., on the same day.

The rate of progress of this Cyclone, in passing Antigua, was 18 miles per hour. At St. Thomas it slackened to 18¼ miles per hour. In Florida it was only 8¼ miles per hour, and farther North only 5 miles per hour. This diminution in the progressive movement may probably be accounted for by the obstruction to the Cyclone created by the hills in several of the islands over or round which it had to pass.

With regard to the diameter of the Cyclone, Mr. Jahncke, of St. Thomas, who seems to have studied the whole phenomena most scientifically, estimated what he calls the "inner or furious part," at about 180 or 200 miles; the entire diameter was about 300 miles. Others, however, judging from the track marked on some of the islands by the damage done, estimated the diameter at only 50 or 60 miles. As to the central part, where a comparative calm existed, that of course was formed by the meeting of opposite winds, just as near the Equator a calm region prevails from the same cause. The diameter of this central cyclonic calm may be estimated; for if it lasted half an hour at any place passed by the Cyclone, and the Cyclone itself was moving forward at the rate of 18 miles an hour, the calm centre must have been about 9 miles in diameter.

The following shows the barometric depression and direction of wind at St. Thomas:—August 21, noon, 29·83, wind N.E.; 1 p.m., 29·57, N.N.E.; 2 p.m., 29·19, N.N.E.; 3 p.m., 29·17, North; 4 p.m., 28·85, N.N.W.; 5 p.m., 28·68, West; 5h 35m p.m., calm; 6 p.m., wind S.W.; 7 p.m., wind S.S.W. The barometer rose gradually after the calm.

This Cyclone is stated to have been *divided into two portions* in passing the high ground (6,000 feet) of Puerto Rico. One part of the Cyclone diverged to the N.N.W., and the other and larger portion proceeded onward W.N.W. The first part of the Cyclone, Mr. Jahncke states, went towards Bermuda, and was encountered by the brig *Ada*, in lat. 26°, long. 69°.

(201.) Mr. Keevil, United States Consul at Martinique, gives the following account of the severe Hurricane which occurred there on August 18th, 1891 (see Track No. XIII. on diagram):—

Early in the morning the sky presented a very leaden appearance, decidedly threatening, with occasional gusts of variable winds, mostly from E.N.E. The temperature was very oppressive during the entire day. The barometer varied only slightly, but was a little higher than usual until the afternoon, when it commenced to fall, at first gradually, and then very rapidly.

It is stated by fishermen, who were in the vicinity of Caraval Rock at 10 a.m., that an immense wave, about 100 feet high, passed from the direction of St. Lucia, closely followed by another smaller one, although the sea in the vicinity was quite calm at the time.

The storm struck the East side of the island at about 6 p.m., rushing through the ravines with terrible force, and destroying everything in its path. On the elevated plains the ruin was most complete. One very peculiar feature of the

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* Notes on West India Cyclones, by D. Milne Holme, LL.D. "Journal of the Scottish Meteorological Society," 1874. See also page 219.

Hurricane was the deafness experienced by every one during the storm (possibly the result of the reduced barometric pressure). During the Cyclone the wind veered from E.N.E. to S.S.E., the latter being the most destructive. During the storm there were incessant flashes of sheet lightning, unaccompanied by thunder, and immediately after the storm there were two distinct shocks of earthquake, at intervals of about five seconds. Early in September I visited Trinité, and all the way the destruction was most complete, the trees and vegetation looking as though there had been a forest fire, although without the charred appearance. The factories and distilleries appear to have been more completely destroyed than other property.

The thermometer ranged from 90° to 100° Fahrenheit during the storm. There was a deluge of rain, one account stating that over 4 inches fell in a few hours that evening. My own residence was unroofed and flooded with water, as was the case with nine-tenths of the buildings in St. Pierre and throughout the island; the loss of life was small in St. Pierre, but large in the interior towns, notably in Morne Rouge, where eight in one family lost their lives. The total loss of life, so far as reliable information can be obtained, was 700, and the loss of property was enormous. All the fruit, the main reliance of the labouring class, was destroyed, and prices of provisions advanced 300 per cent. Every vessel was wrecked or badly damaged, about fifty sail in all. The scene the island presents would be difficult to describe. Such a night of terror the imagination can scarcely picture.

(202.) *Examples of vessels passing through the Vortex.*—In August, 1887, the American steamer *Knickerbocker* was steered right into the heart of a Hurricane. Passing Cape Hatteras, bound South, at midnight, on the 21st, at noon, it was blowing a stiff breeze from E.S.E., with a heavy sea. The course was continued, and on the 23rd, in lat. 30° 10′, long. 77° 28′, a fierce gale from E.S.E. was encountered, with immense cross sea; at 4^h p.m., blowing a Hurricane from East to E.S.E., heavy rain, sea a mass of foam; 9^h p.m., *wind suddenly lulled*, barometer 28·90; 10^h 15^m p.m., wind suddenly came out from W.N.W. to West, in a fearful Cyclone, ship hove-to, terrific rain, the sea lashed to foam. 24th, 1^h 30^m a.m., frightful Cyclone from W.N.W., immense cross sea, barometer 28·20. At 3^h a.m., it began to moderate, the barometer rising gradually.

Captain Roggeveen, of the steamer *Veendam*, reports:—At 8^h a.m., December 1st, 1890, in lat. 41° 13′ N., long. 59° 58′ W., wind E.S.E., force 9, barometer 28·19; long, high-rolling sea, dark stormy-looking sky. At 3^h 45^m p.m., lat. 42° 42′, long. 60° 42′, *it fell calm* with enormously high seas rolling in from S.E. At once the wind came from W.N.W., blowing a full hurricane; barometer 27·95.

ON MAKING USE OF HURRICANES.

(203.) Mr. Piddington suggested that it might be possible to make use of these Storms, by taking advantage of the favourable wind which some portions of their circumference offer for expediting the voyage. This was also proposed by Sir W. Reid, in his "Law of Storms." Mr. Piddington gave rules for this, in the regions he made more particularly his study—the Indian and China Seas.

In order to benefit by the Hurricane, several conditions are necessary; and it need not be again insisted on, that any error or ignorance of the centre of rotation may be fatal. Of course, the first consideration is, in what part of the circumference is the ship, and in what bearing is its centre?—then, at what rate, and in what direction, is it travelling?—and is it so violent that the ship cannot weather it? All these things must be weighed well by the mariner, before he endeavours to lay his ship on that tack which will appear the best to forward his voyage. Should the Storm be advancing in the same direction as his course, and the position of the ship be upon the anterior verge, should it travel at a rate above that which he can keep up, it is evident that it will pass over him, and the consequence need not be remarked upon. Should the vessel be upon the posterior verge of the Hurricane, it will, if travelling at 20 or 30 miles an hour, soon leave her, and then no advantage can follow; and if the Storm be travelling slowly, a vessel in this position might run into the heart of it, owing to the great indraft of the winds, as explained in (155).

Thus, to "make use of a Hurricane," several conditions are absolutely necessary: these are—"1. The ship must get into the Storm precisely where the wind blows fair for the prosecution of the voyage—which is quite a matter of chance. 2. If she happen to do so, she must, to derive benefit, regulate her speed exactly to that of the meteor. Can she do that at pleasure? There would be no difficulty in ascertaining the fact of her preserving her station, or not, by the wind remaining steady, or veering; but there is a necessity that would bind her, and which cannot be evaded with impunity when a high sea follows; she must carry a certain proportion of sail to prevent her from being pooped. Now this sail may give her a greater velocity than the meteor at the time; hence she would run ahead of it. Again, the rate of the meteor may be greater than her utmost speed; hence she would be ejected."

Again, as stated in (163), vessels, making use of the favourable wind on the Eastern side of a Cyclone, must take steps to avoid the Storm at its point of recurving from N.W. to N.E. A vessel steering to the Northward, having the wind aft, may possibly keep up with the progress of the Hurricane; but on reaching its point of recurving would be in danger of having the vortex pass over her.

SQUALLS AND TORNADOS.

(204.) Captain Andrew Livingston, of Liverpool, to whom we are indebted for much valuable information, gives the following description.

"Squalls are generally of *three* kinds. That called the *Arched Squall* is frequently experienced, and usually rises from the horizon in the form of an arch; but sometimes it assumes the appearance of a dense dark cloud, particularly when highly charged with rain, or electric matter. From the time that the arch or cloud is first seen above the horizon, its motion is sometimes very quick to the zenith, the interval being scarcely sufficient to allow a ship to reduce the necessary sail before the wind reaches her, which happens when the cloud has approached the zenith. At other times the motion of the cloud is very slow, and not unfrequently it disappears, or is dispersed, the impulse of the wind being not then sufficient to reach a ship. As a general rule, it may be observed, that if in these squalls there be rain preceding the wind, the latter will probably follow the rain in sudden severe gusts; whereas, if the wind precedes the rain, the squalls are seldom so furious, and terminate in moderate showers of rain. The general rule, however, is often interrupted by the operation of local causes.

"The *Descending Squall* is not so easily discerned as the former, because it issues from clouds which are formed in the lower parts of the atmosphere, near the observer; and when clouds are thus formed, they generally produce showers of rain, and successive squalls of wind. In the Mexican Sea, heavy and very sudden descending squalls come at times from very small clouds. These are scarcely felt until the cloud is almost right over the ship's masts.

"The *White Squall* is not often experienced; but it sometimes happens near to, or within, the Tropics, particularly in the vicinity of mountainous land. This squall generally blows very violently for a short time; and, as it is liable to happen when the weather is clear, without any appearance in the atmosphere to indicate its approach, it is consequently very dangerous. The only mark that accompanies it is the wind."

(205.) Captain FitzRoy says:—"Undoubtedly the worst wind, next to a Hurricane, which a vessel can encounter, is a violent *White Squall*, so called because it is accompanied by no cloud or peculiar appearance in the sky, and because of its tearing up the surface of the sea, and sweeping it along so as to make a white sheet of foam. Of Squalls of this description, frequent in the West Indies, and occasionally felt in other parts of the world, no notice will be given much above the horizon; but, by consulting a good barometer or sympiesometer, and frequently watching the surface of the sea itself, even a White Squall may be guarded against in sufficient time.

"Dark clouds, hard mixed with soft, and inky fragments in rapid motion beneath them, accompanied, perhaps, by lightning and distant thunder, are the forerunners of a heavy squall. Soft shapeless clouds, in which it is impossible to point out a definite edge, usually bring rain, but not wind; and, generally speaking, the more distinctly defined the edges of the clouds are, the more wind they foretell. A little attention to these simple observations, so familiar to persons who have been some time at sea, may save young officers unnecessary anxiety in one case, and prompt them to shorten sail at a proper time in the other."—("Voyage of the *Beagle*," vol. ii., page 49.)

(206.) Mr. F. A. Jahncke,* of St. Thomas, says on this subject:—White Squalls are sometimes terribly destructive to vessels, either capsizing them, or carrying away their masts. They occur with fine weather and a good breeze, but I have not heard that they happen on land, but always at sea. It must be a rapid descent of the Equatorial Wind met below by the Trade Wind, which arrests its circular motion; that must be the cause, as their duration is only for a few moments.

Captain Toynbee remarks that he has been struck by the frequency of Squalls from the direction of the upper current of air in parts of the sea where the lower wind was from nearly an opposite direction. In studying

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* General Remarks on West India Cyclones, by F. A. Jahncke, see "Quarterly Journal of the Meteorological Society," No. 10, April, 1874.

Square 3 (see Sections on Trade Winds and Passages), he found that at the Northern verge of the S.E. Trade the upper clouds very frequently moved from N.E., and Squalls would come from N.E., though the steady lower wind was always S.E. or Southerly, as if the upper current of air sometimes forced its way downward through the lower current, causing the Squall, and then rose again.

White Squall.—On November 14th, 1878, when 160 miles off Cape Sable, the barque *Bel Stuart* was struck by a White Squall, in a comparatively smooth sea and clear sky. At 6 p.m., all hands being on deck, a strange sighing of the wind was noticed, and the sky became suddenly threatening, though the barometer showed a rising tendency. Without a moment's notice, the sea forward seemed to swell up to meet the lowering sky, and swept across the bows, doing much damage to the masts and spars. In a moment the barque was left a comparative wreck wallowing in the trough of the tremendous seas. This seems to show that the vessel ran into an incipient Tornado and Waterspout.

(207.) **Tornados** are formed in a similar manner to Cyclones, from which they differ chiefly in size. Both have a gyratory and forward motion, but a Tornado is much less in area, very rarely attaining a diameter of 1 mile. It consists of an ascending column of air rotating around a region of very low pressure, sometimes the direction and rotation being with watch-hands, but mostly the reverse, according to the researches of Mr. Finley on 600 Tornados occurring in the United States. When these Tornados pass over the land, the central pressure is so low, that the air contained in closed dwellings has been known to burst the doors and windows *outward*, while the enormous velocity of the wind itself sweeps everything before it.

The Tornado derives its appellation from the Portuguese, signifying a whirlwind. It is known on all the coast of Africa, between the Rio Nunez, in lat. 10½° N., and the Equator, but is most severely felt on the Windward Coast, and seems intended by Divine Providence to expel the noxious matter with which the air is so frequently charged. The Tornado first announces itself by the appearance of a small silvery cloud in the zenith, which gradually increases and descends towards the horizon, and the scene becomes veiled over with the most impenetrable darkness. At this moment the functions of nature seem to be paralyzed, and the elements to have ceased their operations; the most profound and solemn stillness reigns around, with scarcely a breath of air from the heavens, in consequence of which the whole physical system feels oppressed with sensations of approaching suffocation; violent and reverberated peals of distant thunder and lightning commence, gradually advancing and increasing to an extreme not easy to describe; the atmosphere, at times, in a continued blaze for minutes, without intermission. At length the gust arrives with sometimes the greatest irresistible violence, the impulse of which no sails can frequently withstand. It is fortunately not of long duration, extending from one to three hours, and concludes with a furious deluge of rain, which descends rather in columns than in drops. The great danger is in the sudden impulse of the gust, which would immediately dismast or overturn a vessel unprepared for the event. Nothing can be more exquisitely delightful than the subsequent clear and pure state of the air, creating an apparent regeneration of the animal as well as of the vegetable world.

Commander E. G. Bourke, R.N., says:—Tornados are met with as far as 10° S., and almost always come from the Eastward, or dead against the prevailing winds: they do not appear to have any rotatory motion, and have scarcely any effect on the barometer; if they cause any change, it is a slight rise on their approach. This is to be looked for, as they work dead against the usual wind, and the two currents of air seem to meet; certain it is that the S.W. wind blows till the squall reaches the observer, when a sudden change occurs to the N.E. It appears to me that the cold upper current of air forces its way against and under the exceedingly hot and moist lower one, forcing it upwards, where it is rapidly condensed into angry-looking clouds which fringe these storms, the Tornado being in this way constantly fed with rain and electricity as it progresses. On the approach of a Tornado, the temperature frequently falls 15° in 3 or 4 minutes. I traced the path of one for 120 miles along the Gulf of Guinea, which travelled that distance in 4 hours, and its course was W.S.W. true. This Tornado I observed on shore at Accra, and by referring to the logs of the men-of-war which were at anchor off other places, I discovered its rate of progression.

Tornados are most violent and frequent in the neighbourhood of Sierra Leone, and also at the island of Fernando Po: they are most frequent at the commencement and close of the rainy season (June to September), and are most violent at the former period; they do, however, occur occasionally throughout the dry season, but I have never seen one during the rainy season proper. They extend a long distance to seaward, in fact, all over the region of the S.W. Monsoon, but diminish in frequency as the distance from land increases. During the rainy season (June to September), especially in the Gulf of Guinea, the S.W. Monsoon (it then being at its greatest strength) frequently blows home to the coast, obliterating the sea and land breezes. On these occasions the weather is most oppressive, as the night temperature remains very high, the diurnal range being but 3° or 4°.—*Journal of the Meteorological Society*, vol. iv., 1878, page 26.

(208.) Captain Henry Toynbee, in his remarks accompanying the Monthly Charts, mentioned in the note on page 136, states as follows:—In April, Tornados occur on the S.W. coast of North Africa. They generally commence with a South-Easterly gust, and then back to the Eastward, sometimes working round until they end at S.W.; but their action does not seem to be always the same. They occur where the Northerly wind is giving way to the Southerly, or the Southerly to the Northerly, as these winds work their way to the Northward or Southward, so that their season varies with the latitude; but they may be said to begin on the Southern part of this coast in April, and to work their way Northward during the summer months; then as the Northerly wind advances to the Southward, they are felt again on the Southern part of the coast in October.

(209.) Dr. A. Borius, of the French Navy, gives the following account, from his experiences of a great number of Tornados in Senegal:*—

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* "Récherches sur le Climat du Sénégal," par Dr. A. Borius.

The Tornado usually follows a day of calm, and of overpowering heat. The South-Westerly breeze, which prevails during the winter season, has given place to calms and light airs from North to N.E. Owing to this direction of the wind, the sky is completely clear of clouds, yet the Southern part of the horizon becomes dark, a small cloudy black mass appears to the South and S.E., and foretells the formation of a Tornado. After a time, which varies from two to four hours, this black mass begins to move and to approach the zenith. This motion is slow, and I have always seen it in a direction nearly from South to North. When the mass of *nimbus* has risen to about 25° above the horizon, it forms a regular semicircle there, beneath which the sky can sometimes be seen. The edge of this moving black mass shows sharply on the blue sky, which is mottled by a few white fleecy clouds, moving with the North-Easterly winds which have become rather more energetic in the lower regions of the air.

When at about 45° from the zenith, this accumulation of clouds presents a most characteristic appearance. It is a vast black circle, a sort of mushroom without a stalk, seen in a three-quarters view from below; its outline clearly defined in front, and to the right and left edges, but ill-defined behind in the part which touches the horizon. These clouds are sometimes, but rarely, furrowed by lightning, and in general no thunder is heard. Below the most distant part of this black mass, large white clouds are seen.

Sometimes the motion of the meteor is so slow, that it takes half an hour to reach the zenith; sometimes scarcely five minutes elapse from the time when the clouds are seen to begin to move until they are fairly overhead. The meteoric mass seen from below has no longer any definite form, the sky being quickly invaded by clouds which seem to move in complete disorder.

It is generally at the moment when the front edge of the Tornado reaches the zenith, often a little sooner, and sometimes only when two-thirds of the sky are covered, that a wind of extreme violence comes from a South-Easterly direction.

This storm lasts at the most for a quarter of an hour, during which time the wind backs to East, then to N.E., North, and finally to N.W.; it then passes to the S.W., lighter at first, but regaining its energies at S.W. The change of wind is not always so regular as this, for sometimes it freshens up again from S.E. Sometimes it gets lighter and lighter until it becomes N.W., and never goes beyond that quarter. In some Tornados the wind stops at North, the Tornado disappears, calm and rain succeed, and then light steady South-Westerly winds. The only constant thing is, the greater force of the wind at the beginning of the Tornado. Its force is only really dangerous quite at the beginning, and when the wind is from the S.E. Sometimes the meteor disappears in 10 or 15 minutes; it then only consists in this rapid motion of the wind, and this passage of black clouds, without rain, or thunder-storm. This is the least frequent form, and is called a *Dry Tornado*.

Generally, when the wind passes to S.W., a thunder-storm bursts, the rain falls with extreme violence for a quarter of an hour, then becomes moderate, and the wind remains light at South or S.W.

It must be remarked that, even when the Tornado is dry, it is always followed by a fall in the temperature, very sensible to the thermometer. This proves that it is not formed at the level of the soil or of the sea, but in the higher regions of the atmosphere, and that the axis of its gyratory movement is not vertical, or that the motion of the air is rather spiral than circular.

Some remarks on Tornados, as experienced off the West Coast of Africa, are given previously, on pages 158—163.

10.—WATERSPOUTS.

(210.) The well-known phenomenon, called a *Waterspout*, which is frequently seen on the Atlantic, proceeding from black dense clouds, always appears in warm weather, generally in calms, or with little wind; but they have been seen during a fresh gale. It has been shown, by the celebrated Dr. Franklin, and other writers, that a Whirlwind on land, and a Waterspout at sea, arise from the same general causes, and may be considered as one and the same. At sea they are commonly harmless, unless ships happen to be immediately under them; but if, in the progressive motion of the whirl, it passes from the sea over the land, and there suddenly breaks, violent and mischievous torrents are the consequence. At sea, after the spout breaks, the water descends in the form of very heavy rain. In the vicinity of a spout, the wind commonly flies round in sudden gusts, and all ships should therefore take in their square sails.

That a Waterspout and Whirlwind are identical has been amply demonstrated by those who have seen this meteor pass from the sea to land, and the contrary. They have both a progressive as well as circular motion; they usually appear after calms and great heats, and mostly happen in the warmer latitudes.

(211.) The general principles underlying the formation of Whirlwinds, Tornados, and Waterspouts, are described as follows by Lieutenant E. Hayden, U.S.N.

A layer of warm moist air at the surface of the sea happens to have above it a layer of cooler and drier air, and sooner or later the warm light air ascends through the cooler heavier air above. Sometimes this takes place over large areas; at other times it is more local, and the lower layer attempts to escape through a break or opening in the upper layer as through a funnel. Under favourable conditions this action becomes very intense, being increased by the moisture of the ascending column becoming condensed, thus liberating latent heat. As the warm air rushes up, it takes a whirling motion, and a suction or partial vacuum is created at the centre, which often draws water for some distance up the centre. The direction of rotation is not always uniform as with Cyclones.

When a Waterspout is forming, its upper portion is often visible first, appearing to descend from the clouds, but by closely examining it with a telescope it will be seen that the motion is upwards; the moisture in the rising air becoming condensed lower and lower down, thus making it appear to be actually descending.

The area from the North coast of Cuba to lat. 40° N., between the United States coast and Bermuda, is pre-eminently a region where Waterspouts are liable to occur. This is owing largely to the warm moist air over the Gulf Stream, and the cool dry air brought over it by the North-Westerly winds coming off the coast.

(212.) Marine Waterspouts, therefore, are caused by the action of atmospheric currents. Malté-Brun thus describes them:—"Underneath a dense cloud, the sea becomes agitated by violent commotions, the waves dart rapidly toward the centre of the agitated mass of water, on arriving at which they are dispersed into aqueous vapours, and rise whirling round, in a spiral direction, toward the cloud. This conical ascending column is met by another descending column, which leans toward the water, and joins with it. In many cases the marine column is from 50 to 80 fathoms in diameter near its base. Both columns, however, diminish toward the middle, where they unite; so that here they do not extend more than 3 to 4 feet in diameter. The entire column presents itself in the shape of a hollow cylinder or tube of glass, empty within. It glides over the sea without any wind being felt; indeed, several have been seen at once following different directions. When the cloud and the marine base of the Waterspout move with unequal velocities, the lower cone is often seen to incline sideways, or even to bend, and finally to burst in pieces. A noise is then heard, like the noise of a cataract falling in a deep valley; lightning frequently issues from the very bosom of the Waterspout, particularly when it breaks, but no thunder is ever heard."

In order to prevent the danger which a vessel would be exposed to by coming in contact with these tremendous columns, it is the practice, where possible, to discharge upon them a cannon-ball, which, passing through them, causes them to burst, and consequently removes all chances of injury connected with them. This phenomenon is accounted for in the following manner:—Two winds meet—a vortex ensues; any cloud which happens to be between them is condensed into a conical form, and turned round with great velocity; this whirling motion drives from the centre of the cloud all the particles contained in it; a vacuum is thereby produced, and water, or any other body lying beneath this vacuum, is carried into it upon the usual and well-known principle. The cannon-ball, breaking this cylinder, which is always partly hollow, causes it to fall to pieces, in the same manner as a touch upon the surface of a bubble reduces the resplendent mass to a drop of common water.

(213.) The following description of a Waterspout, seen during a fresh gale upon the coast of North America, was written by Mr. Murdo Downie.

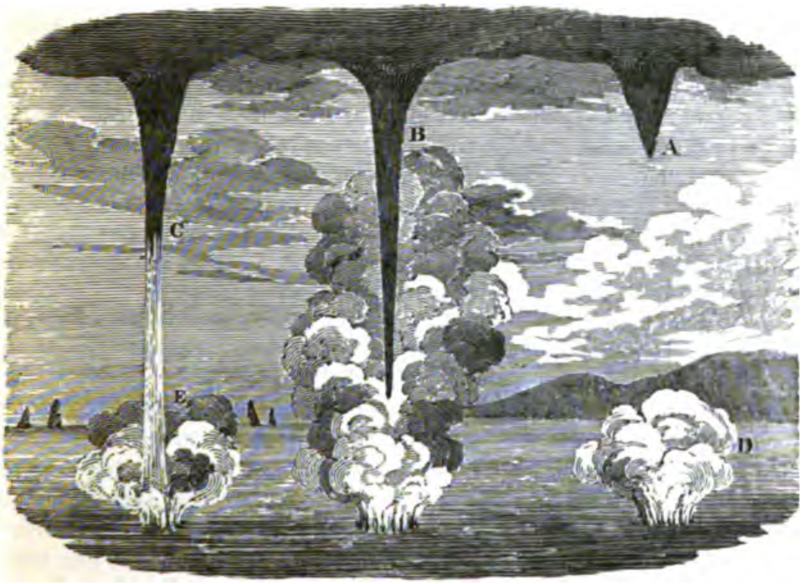
"Upon the forenoon of the 9th of October, 1795, while cruising in His Majesty's ship *Resolution* (then bearing the flag of the late Admiral Murray), in company with H.M.S. *Africa*, commanded by the late Admiral, then Captain, Home, in lat. 32°, and long. 66½° W., having the wind at

N.N.W. blowing a fresh gale, and the ship steering by the wind East for the Islands of Bermuda, we were surprised by a Waterspout, formed in an instant, directly to leeward, at about 2 miles, or little more, distant. Both the *Africa* and we fired several 18-pound shot at it, which fell a little short; and, although some of the shot fell very near, yet they had no visible effect upon it. Its appearance was that of a long slender pillar, with the upper end spreading into a large dense cloud, of which it seemed to form a part, and the lower end reached to within about 20 or 30 feet of the sea, where it was obscured from the sight by water being violently thrown up and agitated, so as to resemble a number of fountains or water-engines playing perpendicularly round the lower end of the spout. The pillar became more transparent in proportion as it decreased in size from the cloud downward, until at the lower end, where it was almost perfectly so; and a small column, of an equal diameter, and more transparent than the rest, appeared up through the middle, so that at about the lower end it resembled an empty glass tube in appearance; from thence the transparent column in the middle became gradually obscured, the higher up, by the opacity of the outside, until it altogether disappeared near the cloud. The spout appeared at its full size, or nearly so, when first seen, and began to decrease shortly after, and in a short time vanished in a slight shower.

"We were too intently gazing at this extraordinary phenomenon to mark the exact time it lasted, but supposed it to continue ten or fifteen minutes; and its distance from the ship was pretty accurately ascertained by the shot fired at it nearly reaching; but what appeared most remarkable was, that, although the wind blew so strong a gale, that the ship could carry only reefed topsails (from which the velocity of the wind cannot be estimated at less than 30 or 40 miles an hour), yet the Waterspout seemed to move but very little from the place where it was first seen. The ship was going at the rate of 5½ miles an hour, and increasing her distance from the spout; yet, after continuing the above-mentioned time, it was considerably within the verge of the visible horizon (about 6 miles), as seen from the quarter-deck, when it vanished. Now, allowing the ship to have increased her distance from the spot half a mile during its continuance, and that it vanished a mile within the verge of the visible horizon, leaves 2½ miles for the spout to move in ten minutes; whereas the wind must have gone at least 5 miles in that time, and consequently 2½ miles faster than the Waterspout. Indeed, it is very probable the Waterspout did not move so much, in proportion to the wind, as the above calculation gives the least difference between their motions that could have been allowed from the observations; the intention of this calculation being principally to prove that the Waterspout in some measure resisted the force of the wind.

"I have always observed that Waterspouts, Lightning, and other electrical phenomena, are far less frequent toward the middle of the ocean than they are upon the land, or near it, and when they happen upon the sea, the cloud that contains them is generally observed to have come from off the land; from which reason we find that electrical phenomena are more frequent, and are found to reach to a greater distance, upon the sea bordering the East coast of North America, than upon that bordering the West coast of Europe; because of the prevailing Westerly winds carrying the clouds charged with electric fluid off the land upon the sea near the American coast; whereas, upon the European coast, these winds confine the clouds upon the land. It is also a known fact, that within the limits of the N.E. Trade Winds, and half-way between the Cape Verde and Windward West India Islands, more especially in the latitude of these islands, scarcely any of these electrical appearances ever happen; whereas, upon the shores of Africa and America, in the same climate, they frequently rage with great fury."

(214.) *Description of Waterspouts by Mr. George Maxwell.*—There can be no doubt that Waterspouts have, in most cases, been accompanied with electrical phenomena; and it is equally certain that the spiral and ascending motion of the water has been produced by a gyratory movement in the air, arising from the meeting of two opposite winds. Mr. Maxwell had opportunities, during several voyages to the Congo, of frequently witnessing this interesting phenomenon; and in a drawing, from which the subjoined figure has been made, he represented the different states of a Waterspout, as they commonly occur.



At their first formation, Mr. Maxwell says, they appear as at A, where the black cloud drops from a level surface into a conical form, before the disturbance at the surface of the sea, as shown at D, is observed. The effect produced at D is like that of a smoking furnace. The black conical cloud now continues to descend, as shown at B, till it almost reaches the surface of the sea, and the smoke-like appearance rises higher and higher, till it forms a connection with the cloud from which the spout appears to be suspended. In this condition it is said to put on its most terrific appearance to vessels which have the misfortune to be in its neighbourhood. When the spout begins to disperse, it assumes the appearance shown at C. The black cloud generally draws itself up in a ragged form, but leaves a thin transparent tube, CE, which reaches the water, where the smoke-like commotion still prevails. Mr. Maxwell observed, at this time, in the upper part of the tube, a very curious motion.

This singular fact, of the existence of a transparent tube, confirms a description, by Mr. Alexander Stewart, of Waterspouts which he saw in the Mediterranean, in 1701. "It was observable of all of them, but chiefly of the large pillar, that toward the end it *began to appear* like a hollow canal, only black in the borders, but white in the middle; and though at first it was altogether black and opaque, yet one could very *distinctly perceive the sea-water to fly up along the middle of this canal as smoke does up a chimney*, and that with great swiftness, and a very perceptible motion; and then, soon after, the spout or canal burst in the middle, and disappeared by little and little; the boiling up and the pillar-like form of the sea-water continuing always the last, even for some considerable time after the spout disappeared, and perhaps till the spout appeared again, or re-formed itself, which it commonly did in the same place as before, breaking and forming itself again several times in a quarter or half an hour."—*Philosophical Transactions*, 1702.

Admiral William H. Smyth, in his interesting volume on Sicily and the Sicilian Islands, remarks that "Waterspouts and various singular meteoric phenomena occur in that neighbourhood. Among the latter, on a warm, cloudy, and hazy day, the 19th of March, 1814, it began to rain in large drops, that appeared muddy, and they deposited a very minute sand of a yellowish red colour. The wind, on the day before, had been blowing strongly from the S.S.W. to the N.E.; and, during the time the rain fell, was from the S.W., which leads to the supposition that it was transported from the deserts of Africa." This remark accords with a number of others on the sand from the *Sahara* or *Desert*, which is carried by the wind over the Atlantic, to an almost incredible distance from the Western coast.*

(215.) To the preceding descriptions we annex another, as given by the Honourable Captain Napier, R.N., F.R.S.E., in 1814.

"On the 6th of September, 1814, in lat. 30° 47′ N., long. 62° 40′ W. (about 140 miles to the S.E. of the Bermudas), at 1^h 30^m p.m., the wind being variable between W.N.W. and N.N.E., the ship steering S.E., an extraordinary sort of whirlwind was observed to form about 3 cables' lengths from the starboard bow of H.M.S. *Erne*. It carried the water up along with it in a cylindrical form, in diameter, to appearance, like that of a water-butt, gradually rising in height, increasing in bulk, advancing in a Southerly direction, and, when at the distance of a mile from the ship, it continued stationary for several minutes, boiling and foaming at the base, discharging an immense column of water, with a rushing or hissing noise, into the overhanging clouds; turning itself with a quick spiral motion, constantly bending and straightening, according as it was affected by the variable winds, which now prevailed from all points of the compass. It next returned to the Northward, in direct opposition to the then prevailing wind, and right upon the ship's starboard beam, whose course was altered to East, in hopes of letting it pass astern. Its approach, however, was so rapid, that we were obliged to resort to the usual expedient of a broadside, for the purpose of averting any danger that might be apprehended; when, after firing several shots, and one, in particular, having passed right through it, at the distance of one-third from its base, it appeared for a minute as if cut horizontally in two parts, the divisions waving to and fro in different directions, as agitated by opposite winds, till they again joined for a time, and at last dissipated in an immense dark cloud or shower of rain. The near edge showered in large heavy drops on the ship's deck, until the cloud was quite exhausted.

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* Colonel Reid, in his "Law of Storms," gives a chapter (xi.) on "Waterspouts and Whirlwinds," with several beautiful figures of the same.

"At the time of its being separated by the effect of the shot, or more probably by the agitation occasioned in the air by the discharge of several guns, its base was considerably within half a mile of the ship, covering a portion of the surface of the water at least half a furlong, or 300 feet in diameter, from one extreme circumference of ebullition to the other; and the neck of the cloud into which it discharged itself appeared to have an altitude of 40° of the quadrant, while the cloud itself extended overhead, and all around, to a very considerable distance.

"Allowing, then, from the ship, a base of little more than one-third of a nautic mile, say 2,050 feet, and an angle of 40° to the top of the neck, we shall then have, for the perpendicular height of the spout, about 1,720 feet, or very nearly one-third of a statute mile. A little before it burst, two other Waterspouts, of an inferior size, were observed to the Southward, but their continuance was of short duration.

"When danger was no longer to be apprehended, I observed the barometer, and found it at 30·1 inches, with the surface of the mercury very convex; an appearance which it had not assumed when at the same height at noon, about two hours before; the thermometer stood at 82°, having risen 1° since that time.

"During the continuance of the Waterspout, and the subsequent rain, which might be a little more than half an hour, the wind blew from all points of the compass at different times, generally shifting at opposite points, never longer than a fresh breeze for a moment, but in most instances quite light. It was unattended with any thunder or lightning, and the water that fell from the cloud was perfectly *fresh*.

"Although this phenomenon was rather terrific in appearance, yet I am not inclined to think it would have been attended with any serious calamity to the ship, had even the whole quantity fallen on board, allowing the loftier sails to have been taken in, the hatches battened down, and scuppers open. The cylinder or spout, coming in contact with the masts and rigging, would naturally be destroyed; and the air rushing in, instantataneously, to restore the equilibrium, the torrent would thus be checked in its fall by the mere weight or force of a tropical descent. I have heard many reports of ravages committed by these aqueous meteors, but never yet met a person who had actually witnessed or experienced any such distressing effects."

(216.) Numerous instances of vessels meeting with Waterspouts, are recorded on the United States Monthly Pilot Charts of the North Atlantic Ocean, from which the following accounts are taken.

In December, 1886, when in a position to the South of the Mississippi, the sailing vessel *Struan* reported that the clouds suddenly dispersed, and the vessel was surrounded by Waterspouts, no less than eighteen being counted near the vessel. They were eventually dispersed by a squall.

Casualties.—On January 14th, 1887, Captain Scott, of the barque *Autocrat*, when in lat. 32° 13′ N., long. 76° 9′ W., had his vessel struck by a Waterspout, which threw her on her beam ends, and did some damage to the deck fittings. On February 9th, 1887, the barque *Winomah*, when in lat. 22° N., long. 40° W., was struck by a Waterspout, and had all her yards broken. On March 25th, 1887, the schooner *Jose Olaverri*, when in lat. 36° N., long. 61° 20′ W., was struck amidships by a large Waterspout, which tore the fore and main sails, and flooded the decks. On February 11th, 1888, in lat. 32° 4′ N., long. 76° 6′ W., the barque *Reindeer*, Captain Strandt, was under full sail, when a heavy Waterspout passed over her, completely dismasting her below the heads of the three lower masts. No previous warning was received; the weather was apparently clear at the time, and the whole affair was over in a few minutes.

Captain Cleary, of the steamer *River Avon*, states that on January 28th, 1888, in lat. 39° 30′ N., long. 57° 20′ W., he saw what he took to be a heavy squall to the S.E. Upon looking at it with his glass, he saw that it was a whirlwind, raising the water to a great height. It must have been over a mile in diameter, but he hesitates to even estimate the height to which the water was raised or the size of the spout, although it must have had terrific power. Shortly afterwards a smaller one passed close to the ship, whirling along the water and raising the spray to a height of fully a hundred feet.

On April 25th, 1891, when in about lat. 30° 30′ N., longitude 76° W., the schooner *Baltic* was suddenly struck by a Waterspout, and thrown on her beam ends. A boat was carried away, and the mainmast had to be cut away to right the vessel. On April 10th, 1888, in lat. 41° 59′ N., long. 47° 30′ W., Captain McKay, of the steamer *Pavonia*, observed a large Waterspout, accompanied by several smaller ones, travelling to the N.E. at the rate of 30 miles an hour, and the vessel's course had to be changed to avoid them. It was in shape like a huge hour-glass, accompanied by a terrific roaring, and the water at its base churned into such a commotion that it shook the great steamer. The spout broke amid lightning, thunder, hail, and rain; and pieces of ice, some 4 to 6 inches in diameter, fell on deck.

On April 29th, 1889, at about 6^h 30^m a.m., when situated about 4 miles to the North of Royal Island of the Bahamas, Mr. C. L. Calloway, chief officer of the steamer *Santiago*, observed a Waterspout from off the starboard bow, which broke about 30 yards from the ship, and *salt* water fell in drops on the deck. The whirlpool appeared from 50 to 70 yards in diameter, the water circling from West to East, or against the sun. The water was whirling very rapidly for several minutes after the break, showing what tremendous circular force there must have been.

II.—THE TIDES.

(217.) As introductory to a General Table of the Tides, we shall give a few passages from *M. Malté-Brun*, explanatory of the subject; and also the results of the extensive observations and profound researches of *Professors Airy* and *Whewell* and the late *Sir John Lubbock.*

The water of the sea yields to the slightest impression; and, although its density and weight combine to retain it in constant equilibrium, it is agitated to a certain depth by rapid and varied motions. These motions may be classed according to the manner in which the particles move, and according to the nature of the agents which cause the motion.

Three kinds of motion may be distinguished in the sea, considered in reference to their causes. The *Tides* are *sidereal motions*, because they depend upon the influence of the heavenly bodies. *General Currents*, and the greater number of *Particular Currents*, have their causes in the very element that is agitated by them; these, then, are *motions of the sea itself.* The third kind comprehends *Atmospheric motions*, produced by the action of the *Winds.*

The Tides are regular and periodical oscillations, which the seas undergo from the attraction of the celestial bodies, principally those of the moon and sun.

(218.) *Action of the Moon.*—Let us first consider the single action of the moon upon the sea; supposing that luminary to be in the plane of the Equator. It is evident that, if the moon exerted upon all the particles of the sea an equal attraction, and parallel to the earth's centre of gravity, the entire system of the globe, and of the waters which cover it, would be influenced by a common motion, and their relative equilibrium would not suffer any change. The equilibrium is disturbed only by the difference between the attractions which the moon exerts, and the inequality of their directions. Some parts of the globe are *directly* attracted by the moon; others only obliquely. The former are in conjunction with the moon; and a line drawn from the centre of the two planets would pass through their zenith. The latter are in quadrature with the moon—that is to say, a line drawn from the terrestrial centre to their zenith would make an angle of 90° with the line which connects the centres of the two planets. The attracting force acting obliquely is decomposed by the obliquity of its angle of incidence; thus the parts in conjunction being more strongly attracted than those in quadrature, the weight of their particles is diminished. It is necessary, then, to there being an equilibrium in all parts of the sea, that the waters should rise under the moon, in order that the excess of weight of the particles in quadrature, above those in conjunction, may be compensated by the greater height of the latter.

The waters, however, rise, not only on the side where the attracting planet is, but also on the opposite side; because, if the planet attract the superior waters more than it attracts the centre of the earth, it also attracts this centre more than it attracts the inferior waters in the opposite hemisphere. These waters will then approach less toward the attracting planet, than the centre of the earth approaches to it. They will remain as far off, from and behind the centre, as the superior waters advance from it on the side of the moon.

Two promontories, or eminences of water, will therefore be formed by the action of the moon upon the earth; one on the side toward the moon; the other on the side opposite to it; which gives the sea an appearance of an elongated spheroid, whose great axis will pass through the centre of the moon and of the earth. It is *High Tide* under the moon and in the opposite point at 180° of distance; consequently, in the two intermediate points, or at 90° of distance from the moon, the tide will be *Low*.

The earth, by its rotatory motion, successively presents to the moon, in the space of twenty-four hours, all its meridians, which, consequently, are found by turns, and at an interval of six hours, sometimes under the moon, and sometimes at a distance of 90° from it; hence it follows that, during the time which passes between the departure of the moon from one meridian, and its return to the same meridian, that is, in the space of a lunar day (which exceeds the solar day by about 50½ minutes), the waters of the sea will ebb twice, and flow twice, in every part of the earth, although in a manner almost insensible in those places which are distant from the path or orbit of the moon.

(219.) *Action of the Sun.*—If we now imagine the sun to be in the plane of the Equator, it is evident that, as its action is similar to that of the moon, it should excite in the ocean an agitation similar to the lunar Tides. Thus the sea would ebb twice, and flow twice, during a solar day; but, on account of the immense distance from the sun, those solar Tides will be much smaller than those which result from the action of the moon.

On account of the inequality which exists between the solar and lunar days, the action of the sun will sometimes change the position of the lunar Tides, and at other times will unite its influence with that of the moon. In the syzigies, or conjunctions, the action of the moon concurs with that of the sun to raise the waters. This is the reason why the highest Tides happen at new and full moon; or when the moon is in its first and third quarters. In the quadratures, the waters of the sea are depressed by the action of the sun, at the same point where the action of the moon raises them, and reciprocally. Thus the Tides of the quadratures ought to be less.

(220.) *The Height of the Tidal Wave* produced by the moon is to that produced by the sun as 100 to 38. When combined, of course, they produce the *spring* tide; opposed, they make *neaps*. The *range* of these tides is as 138 to 62, or nearly as 7 to 3; Newton (from the Severn tides) made it 4·48 to 1, which is far too large. Laplace (from the Brest observations) made it 2·90 to 1; and the late Sir John Lubbock and Dr. Whewell, about 2·66 to 1. Of course, these relations are very much controlled in action by the configuration of the coast or channel.

(221.) What we have already explained regards the position of the sun and moon on the Equator. Let us now consider these heavenly bodies in their various declinations, and we shall see the elevation vary in the inverse ratio of the cube of the distance of the water.

Without entering into details, which would require mathematical demonstrations, we shall remark only, that the proximity of the sun and moon seems to be the cause to which we must refer the extraordinary *equinoctial* tides, which happen most frequently, the one before the *vernal equinox*, and the other after the *autumnal;* that is, both of them at the time when the sun, passing through the meridional signs, is nearest us. But this does not happen every year, because there are sometimes variations produced by the situation of the orbit of the moon, and by the distance of the syzigies from the equinoxes.

(222.) This, then, is the general *Theory* of the Tides, and from these observations their general laws may be inferred; but it has been reserved for later times to pursue the inquiry into detail, and to develop the minor effects which modify, and in some places totally change, the character of the Tides. It is chiefly to the late *Rev. Dr. Whewell,* Master of Trinity College, Cambridge, and to the late *Sir John Lubbock,* that our present knowledge of the Tide laws is owing, and from their observations we will give some extracts.

(223.) In the Rev. Dr. Whewell's papers on the subject of the Tides, he commences:—"Ever since the time of NEWTON, his explanation of the general phenomena of the Tides, by means of the action of the moon and the sun, has been assented to by all philosophers who have given their attention to the subject. But, even up to the present day, this general explanation has not been pursued into its results in detail, so as to show its bearing on the special phenomena of particular places—to connect the actual Tides of all the different parts of the world—and to account for their seeming anomalies. With regard to this alone, of all the consequences of the law of universal gravitation, the task of bringing the developed theory into comparison with multiplied and extensive observation is still incomplete; we might say, is still to be begun.*

(224.) *The Tidal Wave.*—The tidal wave is not owing to the transfer of the body of water, which would be a current, but to an *elevation* of its surface. This motion is, as may be readily conceived, compatible with immense velocity; and it may be taken as a rule, that the broader the wave, the greater will be its velocity. If the earth were in equilibrium, and its surface entirely covered with water, and under the influence of the moon's attraction, it would assume the form of an ellipsoid, having the semi-axis directed towards the moon longer by about 58 inches than that transverse to it; that is, the water would become higher by that amount. This is merely adduced to show what may be the amount of the luni-tidal wave, without entering into any other considerations.

(225.) *Velocity of the Tidal Wave.*—As the whole of the tidal wave must circulate around the globe in twenty-four hours nearly, the velocity must be very great; but it is greatly modified. In the middle of the Atlantic it would appear to travel at the rate of about 700 miles an hour, but on the coast it is widely different; hence its velocity along the Eastern coast of England varies from 35 miles to 160 miles per hour.

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* "Essay towards a First Approximation to a Map of Cotidal Lines;" Philosophical Transactions of the Royal Society, 1833, page 147.

In the open ocean, where nothing intervenes to obstruct the course of the tidal wave, it travels probably with regularity; and it may be presumed that its height is also inconsiderable. But when this wave, from an open ocean, approaches a narrow channel—such as the Bristol or English Channel—from being hemmed in, as it were, it forms a *tide current*. Now, along the centre of such a channel the tidal wave would travel with much greater speed than on the sides. Hence the distances at which the hour-marks represent high water will be wide apart in the centre, and transverse to its general direction; while, on the shores, the direction of the wave would be altered, and it will approach parallel to the shore; hence the hour-marks will be close together, and parallel to the general direction of the main tide-current.

The tide-wave, advancing through the contracting channel, towards the end becomes of great height, and, as at Bristol, and in the Bay of Fundy, sometimes rises to the enormous height of 50 or 70 feet; just in the same manner that the surf runs up a shelving beach.

The variation in the height of the Tide (as is found to be the case in some parts of the coast of France) between places near each other, and having high water at the same time, is to be accounted for by the convex form of the tidal wave.

In some parts of the world, as in Australia, Kamschatka, &c., the Tides offer very singular anomalies. At Adelaide, in South Australia, it is high water only once in the twenty-four hours, and that during the night. This arises from what are called *interferences*, whereby two distinct sets of tidal waves, in their combination, produce apparent rest.*

(226.) One of the most important circumstances of this subject is, that, in an open channel, the *flood current* (the current which runs till high water) will continue running for three hours afterwards, or till *half-ebb;* and the *ebb current*, which then begins, will run after low water till half-flood. The time of slack water is intermediate between the times of high water and low water. In proportion as the channel is obstructed at the farther end, the flood current runs for a shorter time after flood; and in a closed creek, the flood current ends at high water.†

Another error to correct is this:—"That the time of the change of current, or the *time of slack water*, as it may be termed, *never* coincides with *the time of high water*, except close inshore, and within its influence; the interval is generally considerable. Great confusion has arisen from these two times not being properly distinguished."—*Phil. Trans.*, 1833, page 162.

(227.) *The Establishment of the Port.*—The vulgar establishment of the port is the interval of time by which the time of high water follows the moon's transit *on the day of the new and full moon.* This is, corrected, the *mean* value of the interval, freed from the semi-menstrual inequality. Its value at the London Docks is $1^h\ 26^m$ minutes, by the mean of all the observations.—*Phil. Trans.*, 1834, page 19.

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* Phil. Trans., 1833, page 154.

† Phil. Trans., 1833, page 215.

The Corrected Establishment.—The mean luni-tidal interval, or *corrected establishment* of each place, differs from the vulgar establishment, or time of high water for new and full moon; for the time of high water at syzigy is affected by the semi-menstrual inequality belonging to the moon's position one or two days earlier, and is therefore later by about thirty minutes than the mean interval would give it.*

(228.) *Semi-menstrual Inequality.*—The interval of tide and moon's transit is affected by a considerable inequality, which goes through its period *twice* in the space of one month; it may be considered as depending upon the moon's distance from the sun in right ascension, or, which is the same thing, on the solar time of the moon's transit. The difference of the greatest and least intervals at London is $1^h\ 28^m$.†

(229.) *The Age of the Tide.*—The Tide does not depend upon the passage of the moon upon that particular day or hour, but from some previous transit; hence the Tide is observed to take place at London at two o'clock on the days of new and full moon; therefore, as the Tide of London is found to be determined by the position of the sun and moon upon two days and a half before it occurs, $1^h\ 26^m$ is the *corrected establishment* for London, as explained in (227).‡

(230.) *Difference of the Two Diurnal Tides.*—It has been remarked in various places, by separate observers, that the evening Tide is higher than the morning Tide in one part of the year, and lower at another. This is thus explained by Newton. From the vernal to the autumnal equinox, the sun has North declination; and as the moon's orbit is never much inclined to the sun's, a line drawn from the earth's centre to the moon would meet the earth's surface, on the side towards the sun, in North latitude. Now, such a line is the axis of the tide-spheroid, supposing the Tide to be always under the moon; and the Tide taking place when the moon in the meridian is higher, as the place is nearer to the vertices or points where the axis of the tide-spheroid meets the earth's surface. Hence, in this case, the Tides which occur on the side of the earth next the sun, or the day Tides, would be larger for a place in North latitude than the Tides on the opposite side. For a similar reason, the night Tides would be higher in winter.

(231.) *Height of Mean Water.*—The mean between high and low water is found to be constant and permanent, however much may be the difference of high and low water. It has been found, from a great number of observations on the South coast of England, not to vary more than 2 or 3 inches; therefore all heights ought to be referred to the *mean* level of the sea, instead of the vague and uncertain data of high or low water.

The refined surveying operations have demonstrated one singular fact, which could only have been elicited in the laborious and exact processes carried on during the Ordnance Survey. It is, that the *mean level* of the sea, as we assume it, is *not a level*, from whatever cause it may arise, and it is difficult to assign one. It is found that the *mean* level of the sea around Ireland is lower on the South than it is on the North coast.

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* Phil. Trans. (Whewell), 1836, page 292.

† Phil. Trans., 1834, page 19.

‡ Phil. Trans., 1839, page 154.

Taking Courtown in Wicklow as the standard—a spot remarkable as the node or axis of the great tidal wave of the St. George's Channel, and where there is little or no rise or fall; at Ballycastle on the North, the mean sea level is higher by 0·881 foot, and lower on the South at Castle Townsend by 0·938 foot, than it is at Courtown. Thus the mean level is nearly 1 foot 10 inches higher on the North than it is on the South of Ireland. Of course this fact has no bearing upon the seaman's application of tidal phenomena, but it is curious.

(232.) It has been found that a low barometer causes a higher Tide and the reverse. This element in the disturbance of the regular Tides, the effects of atmospheric pressure, has been estimated by different observers, and its amount has been ascertained with considerable accuracy. Thus, at Liverpool, there is a difference in the *height* of high water of 10·1 inches for a variation of 0·91 in the barometer; and at London it has been calculated by Mr. Dessiou that the water rises 6·3 inches for ·90 depression of the barometer. M. Daussey has ascertained that, at Brest, the ocean rises ·223 metre, or 8·78 inches, for a depression of 0·158 metre, or ·622 inch, in the barometer.* These results are nearly identical with those ascertained by Sir James Ross in the Arctic regions, in 1848, by means of the steady level of the winter ice. These refinements in tidal calculations are, perhaps, of little practical value for the mariner when at sea; they may be useful in entering a dock; but they are of the utmost service in generalizing the phenomena of the Tides, upon which so little, it may be said, is known that may be applied.

(233.) The foregoing are the principal effects of the causes which produce the Tides in reference to their rise and fall. There is another branch of the subject, however, which is of great importance to the navigator; that is, the currents formed by the alternate elevation and depression of the ocean. As before mentioned, in the open sea it may be considered that there is no tidal current, and that the tidal wave is propagated without any actual displacement in the particles of the water. But when this wave approaches the coast, the case is widely different, and the wave must necessarily form a current, sometimes flowing in one direction, and at others in the opposite one. This variation in the progress of the flood and ebb tide-wave must vary with every locality, and is influenced by the particular configuration of the coasts, &c., by which it passes. The question of the form and transmission of waves is so complicated, and involving mathematical analysis of so high an order, that it cannot be usefully dwelt on here.

Upon the direction in which the great tidal wave is propagated, we at present have much to learn. It was supposed by the late Sir J. Lubbock, that it travels from the Cape of Good Hope to Gibraltar in twelve hours; from Gibraltar to Edinburgh in about twelve hours; and from Edinburgh to London in about twelve hours,† which is in accordance with Bernouilli's theory. Passing North-Eastward from the South Atlantic, it strikes the S.W. shores of Great Britain and Ireland, and becomes divided by these lands; one portion of the great wave passes Northward to the West of Ireland, a portion of it enters by the North Channel, and meets a large portion from the South which has passed up the St. George's Channel; another passes up the English Channel passing on to the North Sea along the Dutch and German coasts, and with another portion of the Western branch which enters the North Sea between Norway and Scotland, causes a circulation of tides which is still involved in some obscurity, but which is elucidated elsewhere; the remainder passes North-Eastward along the Norway coast on to the Polar basin. Along the American coast the great wave passes from South to North, making high water at a later hour continually, and entering the various bays and outlets in the same manner. It may at once be mentioned that in low latitudes the rise and fall of the Tide is very inconsiderable, and therefore comparatively unimportant.

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* Phil. Trans., 1836, pp. 220, 221; and Conn. des Temps, 1834.

† Phil. Trans., 1836, page 218.

(234.) In 1834, from the recommendation of the Rev. Professor Whewell, a series of Tide observations were made, during a fortnight in the month of June, at the coastguard stations in Great Britain and Ireland; and in the following year a much more extensive series was taken simultaneously between the 8th and 28th of June. "The chain of places of observation extended from the mouth of the Mississippi round the Cays of Florida, along the coast of North America, as far as Nova Scotia; and from the Straits of Gibraltar, along the shores of Europe, to the North Cape of Norway. The number of places of observation was twenty-eight in America, seven in Spain, seven in Portugal, sixteen in France, five in Belgium, eighteen in the Netherlands, twenty-four in Denmark, and twenty-four in Norway; and observations were made by the coastguard of this country at 318 places in England and Scotland, and at 219 places in Ireland." This large number of observations was also undertaken at the instigation of Professor Whewell, and their reduction was made by Mr. Dessiou and assistants, under his directions. The details and results are given in the "Philosophical Transactions," 1836, page 289, *et seq*.

These observations gave a far greater insight into the nature of the tidal progress than was had previously. A still more refined series was carried on for the English Channel by Admiral Beechey, as hereafter shown.

(235.) In the ensuing Tide Table for the North Atlantic Ocean, the *vulgar* establishment (227) is given as the tidal hour at full and change. These figures are taken chiefly from the various Government Nautical Surveys and the special observations which have been made in various places, as given in the Tables published by the Hydrographic Department of the Admiralty, the United States Coast Survey, &c.

The height of the tide is here quoted as the vertical rise above the mean low-water level of spring tides.

Attached to the Table are some brief remarks on peculiarities of the tidal phenomena, in the form of notes.

TIDE TABLE.

The Figures in Brackets (1), (2), *&c., refer to the subjoined Notes.*

Place.	High Water, Full and Change.	Rise.	
		Sps.	Nps.
England—Thames and South Coast.	h. m.	ft.	ft.
London Bridge (1)...	1 58	20¾	17¼
London Docks	1 53	20¾	17¼
Gravesend	1 5	18½	15
Nore	0 30	15½	13
Margate	11 45	15½	13
Ramsgate	11 44	15	12
Deal	11 15	16	12½
Dover (2)	11 12	18¾	15
Folkestone	11 7	20	16½
Dungeness	10 45	21¾	19
Rye Bay	11 20	22	17¼
Hastings	10 53	24	17½
Beachy Head.........	11 20	20	15
Newhaven	11 51	20	15
Shoreham	11 34	18	13¼
Littlehampton Bar	11 20	16	11½
Selsea Bill	11 45	16½	12½
Portsmouth Dock Yard	11 41	13½	10¾
Southampton (3) ...	10 30 0 45	13	9½
West Cowes	10 15 11 15	12½	9½
Hurst, Camber	10 0 noon	7½	6
Needles Point	9 46	7½	5
Christchurch	9 0 11 30	5	
Poole, entrance	8 50 0 25	6½	4¾
Portland Breakwater	7 1	6¾	4¼
Bridport	6 5	11¼	7¾
Exmouth	6 21	12¼	8½
Torbay..................	6 0	13½	10
Dartmouth............	6 16	14¼	10½
Devonport Dock Yard.................	5 43	15½	12
Plymouth Breakwater	5 37	15½	11¼
Fowey	5 14	15	11¾
Falmouth	4 57	16	12
Truro	5 5	10	6
Lizard....................	5 0	14¼	10½
Penzance	4 30	16¼	12½
Scilly Isles, St. Agnes	4 30	16	12
England and Wales—West Coast.			
St. Ives	4 44	21	15
Padstow	5 13	20½	16¼
Lundy Island (4) ...	5 15	27	20
	h. m.	ft.	ft.
Barnstaple Bar	5 30	19	10
Bideford	6 7	16	8
Ilfracombe	5 42	27¼	21¼
Bridgewater Bar ...	6 50	35	26½
Flatholm Island ...	6 56	37¾	29
King Road	7 13	40	31
Bristol..................	7 13	31½	
Sharpness	7 58?	28?	15?
Chepstow	7 30	38	28½
Newport	7 10	38	29
Cardiff, Penarth ...	6 56	37½	29
Barry Island	6 50	37½	28½
Porthcawl	6 8	28½	21¼
Swansea, Mumbles	6 0	27¼	20¼
Llanelly Bar	6 16	25	18¼
Tenby	5 55	25½	19¼
Milford Haven (entrance)	5 56	24	18
Pembroke Dock Yard	6 12	22½	17
Cardigan (5)	7 1	12	9
Aberystwith	7 37	14¼	10
St. Tudwall Road...	7 44	14	10½
Bardsey Island	7 40	15	
Caernarvon............	9 27	15¾	12
Holyhead	10 11	16	12½
Beaumaris	10 28	22½	15½
River Dee, Air Point	10 54	25	19
Chester	12 16	10	
North-West Lightship	11 0	25	20
Liverpool	11 23	27½	20¼
Formby Point	10 35	25¼	19
Ribble Lighthouse...	10 51	25½	19
Fleetwood, Wyre Lt.	11 11	27½	20½
Port	11 12	27	20½
Lancaster	11 16	8¼	2
Poulton-le-Sands ...	11 26	27¼	21½
Piel Harbour (Pier)	11 5	28	21
Whitehaven	11 14	26	19
Workington	11 4	25¾	20
Maryport	11 26	25	19
Port Carlisle	0 10	20	14
Southerness	11 50	27½	19½
Annan Foot	0 5	28½	20
Isle of Man.			
Douglas	11 12	20¾	16
Ramsey	11 12	20¾	16
Peel	11 8	16½	13
Calf Sound............	11 17	16¼	13
Port St. Mary	11 10	20	16
Castletown............	11 10	20	16

Place.	High Water, Full and Change.	Rise.	
		Sps.	Nps.
Scotland, West Coast.	h. m.	ft.	ft.
Kirkcudbright	11 10	23	17
Port Patrick	11 10	15	12
Loch Ryan	11 12	11	8
Campbellton	11 45	8¼	6
Ayr	11 50	8¾	7¼
Troon	11 50	10	7½
Ardrossan	11 45	10	8
Largs	11 50	10	
Greenock	0 8	10	8¼
Port Glasgow	0 18	9	
Dumbarton	0 20	10½	
Glasgow	1 8	11¼	9¾
Burnt Isles, Kyles of Bute	11 50	10	8
Ardrishaig, Loch Fyne	11 53	9	7½
Inverary	noon	10	
Gigha Sound	2 22	4	2¼
Jura, East Coast	4 56	8½	2¼
Easdale Sound	5 10	10-12	
Crinan	4 49	6	3-4
Loch Aline	5 33	13¾	10½
Oban	5 22	12	9½
Loch Eil	5 15	13	10
Tobermory, Mull	5 36	13	9½
Portree, I. of Skye	6 32	15	10¾
Kyle Akin	6 16	15½	11
Ullapool, Loch Broom	6 40	14½	10½
Poolewe, Loch Ewe	6 20	14½	10½
Berneray, Island of Harris	6 11	13	9½
Stornoway	6 46	13½	9½
Cape Wrath	7 30	15½	
Thurso	8 23	13¼	9½
Stroma, South side	9 47	9	6½
Swona, East side	10 24	10	7½
West side	9 35	10	7
Great Skerry, East side	11 4	7¾	6½
Orkneys.			
Stromness	9 0	10	7½
Kirkwall	10 9	10	7½
Deer Sound	10 30	10	7½
Widewall	9 3	10	7½
Otterswick	9 13	11	8
Shetland Isles.			
Balta	9 45	6½	4½
Lerwick	10 30	6	4½
Scalloway	9 30	5¾	4½
Sumburgh Head	9 45		
Fair Isle	11 0	5	3
Scotland, East Coast.			
Duncansby Ness	10 14	10	7
Wick	11 22	10	7½
Cromarty	11 56	14	11
Dingwall	11 39	13	9¾
Inverness	0 18	12	9½
Peterhead	0 34	11½	9½
Aberdeen	1 0	12	10
Montrose	2 17	14	11
Arbroath	1 35	14	11
Tay Bar	2 6	16	13½
Dundee	2 32	14½	11½
Burntisland	2 24	16½	12¾
Leith	2 17	16½	12¾
Alloa	3 18	17½	15
Dunbar	2 8	14½	11
Berwick	2 13	15	11½
England, East Coast.			
Holy Island Harb.	2 30	15	11½
Blyth	3 15	15	11
Tyne River Bar	3 20	14¾	11½
Newcastle	3 32	15½	11¾
Hartlepool	3 28	15	11¾
Sunderland	3 22	14½	11
Tees River, Bar	3 45	15	12½
Whitby	3 45	15	11½
Scarborough	4 11	15¾	12¾
Flamborough Head	4 30	16	12
Humber Riv., Spurn Point	5 26	18¾	15
Hull	6 29	20¾	16½
Goole	7 26	13	
Lynn Deep, Long Sand	6 0	23	16½
Cromer	7 0	14¾	11
Leman and Ower Lightvessel	7 15	9	
Yarmouth Haven	9 15	6	4½
Lowestoft	9 57	6½	5½
Orfordness	11 15	8	6½
Woodbridge Haven, Bar	11 45	12	9
Harwich Harbour	0 6	11½	9¾
Orwell River, Ipswich	0 35	13½	
Gunfleet Sand, N.E. end	11 50	12	8
The Naze	11 50	12½	10
Maplin Lighthouse	0 5	14	10
Ireland, South and East Coasts.			
Cape Clear	4 0	9	6½
Baltimore	4 23	10½	8½
Kinsale	4 43	11½	9
Queenstown	5 1	11¾	9
Cork	4 58	12¾	10
Ballycottin	4 54	12	9½
Youghal	5 14	12¾	10
Ballinacourty, Dungarvan	5 12	12½	9½
Waterford, Duncannon Fort	5 20	12½	10
Bridge	6 6	13½	10¾
Wexford (6)	7 21	5	3½

Place.	High Water, Full and Change.	Rise.	
		Sps.	Nps.
	h. m.	ft.	ft.
Arklow	8 0	4	2¾
Wicklow	10 29	9	6½
Dalkey Island	10 45	13	11
Kingstown	11 12	11¼	8¾
Dublin Bar	11 12	12-14	9-11
Howth Harbour	11 9	13	10
Balbriggan	10 40	13	
Dundalk	10 56	15	11½
Carlingford Bar	11 0	16	11
Ardglass	11 0	16	12
Lough Strangford, Killard Point	10 58	14	11½
Strangford Quay	0 31	10½	8¾
Ireland, North and West Coasts.			
Donaghadee	11 13	11¼	9½
Belfast	10 43	9½	8
Lough Larne	10 48	6¾	6¼
Red Bay, pier	10 31	4	4
Ballycastle Bay	6 25	3	2
Port Rush	6 8	5¼	3¼
Coleraine	6 24	6¼	4
Lough Foyle, Moville	7 6	7½	5½
Londonderry	8 1	7¾	5¾
Rathmullen, Lough Swilly	5 42	12½	9
Sheephaven	5 32	11¾	8½
Gweedore Bay	5 32	11	8
Donegal Harbour	5 18	11½	8½
Killibegs	5 16	11¼	8½
Ballyshannon Bar	5 18	11¼	8½
Sligo Bay, Oyster Island	5 23	11½	8½
Killala Bay	5 22	10¼	8
Broadhaven Harbour	5 0	10½	7½
Achillbeg	5 14	10¾	8
Westport	4 57	12¾	9½
Inishbofin	4 34	12¼	9½
Roundstone	4 28	13½	10¼
Greatman Bay	4 39	15½	11¼
Killeany, Arran Is.	4 28	13½	10
Galway	4 35	14¾	11
Liscanor Bay	4 23	13¾	10
River Shannon, Limerick	6 10	18¾	13½
Foynes Island	5 35	15½	12
Tarbert	4 57	14½	10½
Kilbaha	4 16	13	9½
Smerwick	3 50	11½	8
Castlemaine	4 30	14¼	9½
Dingle	3 51	10¾	7¾
Valentia Harbour	3 42	11	8
Kenmare River, West Cove	3 52	10	7½
Bantry Harbour	3 47	10	7½
Castletown, Bearhaven	4 14	9¾	7½
Black Ball Harbour	3 40	9½	7¼
Dunmanus Harbour	3 57	9½	7¼

Place.	High Water, Full and Change.	Rise.	
		Sps.	Nps.
	h. m.	ft.	ft.
Crookhaven	4 9	9¾	8
Skull	4 2	9¾	7½
Cape Clear	4 0	9	6½
Norway, &c.			
Iceland, Reikiavik	5 0	17½	13¼
Færoe Islands, Fugloe Fiord	11 15	6½	4½
Leervig Fiord	0 30	6½	4½
Waagoe Fiord	6 0	9½	7½
Eides Fiord	11 0	9½	7½
Archangel	7 28	2½	
Sviatoi Nos	9 15	14	
Vadsö	6 30	6-8	
Hammerfest	1 10	9	
Lofoten Islands	0 31	9½	7½
Værö	noon	9	7½
Træ Islands	11 45	7	
Trondhjem Bay	11 14	8-9	
Romsdals Islands	10 45	6	
Bergen	1 30	4	
North Sea, E. Coast.			
Skagen or the Skaw	5 56	1	
Blaavand Point	1 44	7	5
Hjerting	2 45	4¾	
Eider, Tönning	1 55	11½	
Elbe, Hamburg	5 10	6¼	
Cuxhaven	0 49	10¼	
Entrance	noon	11	6
Helgoland	11 48	9	4
Weser, outer lightvessel	0 20	9¾	
Bremerhaven	1 4	10¾	
Wilhelmshaven	0 52	11¼	
Wangeroog	11 37	8¼	
Borkum	10 30	7	
Ameland Gat	9 30	6¼	
Terschelling (West)	8 40	6	
Harlingen	9 0	5½	
Amsterdam	3 0	18	
Nieuwediep	7 27	4	
Texel Bar	6 0	4¼	3½
Ymuiden	3 0	5¼	
Rotterdam	3 45	7	
Brielle	3 0	5	
Hellevoetsluis	2 30	5½	
Flushing	0 54	15	11
Antwerp	4 25	15	
Ostend	0 25	15	11
Nieuport	0 18	16	13
France, North Coast.			
Dunkerque	0 8	16¾	13½
Gravelines	noon	19	15½
Calais	11 49	21	17½
Cape Grisnez	11 27	21½	16¾
Boulogne	11 28	25¼	19¾
Cayeux	11 14	28½	22
Dieppe	11 8	27½	21

Place.	High Water, Full and Change.	Rise.	
		Sps.	Nps.
	h. m.	ft.	ft.
Fécamp	10 47	23½	18
Havre (7)	9 18	22	18
Honfleur	9 29	23	18
Barfleur	8 59	17	13½
Cherbourg	8 0	17¾	13
Alderney	6 46	17½	12¾
Guernsey, St. Peter	6 37	26	18¾
Jersey, St. Helier	6 29	31½	23
Carteret	6 25	31	22½
St. Germain	6 20	34	25
Régneville	6 20	35	26
Granville	6 9	37	27½
Iles de Chausey	6 14	35	26
Cancale	6 20	37	27
Les Minquiers	6 6	35	26
St. Malo	6 5	36½	25¾
Brèhat	5 51	31	23½
Héaux Lighthouse	5 45	31	23½
Tréguier	5 32	28	18½
Ploumanach	5 15	24½	18½
Morlaix Road	4 58	24	18
Ile de Bas	4 52	23	17
Abervrac'h	4 14	22	16
Ushant (8)	3 46	19½	13¾
France, West Coast.			
Brest	3 47	19½	14½
Ile de Sein	3 21	17¾	12
Concarneau	3 12	13	9½
Port Louis, L'Orient	3 11	13	9½
St. Nazaire	3 47	17	13
Ile de Noirmoutier	3 17	17	13
Ile d'Oleron	3 50	19	
La Rochelle	3 5	16½	11½
Rochefort	4 0	16¾	13
Ile d'Aix	3 35	16¾	13
Gironde River, Cordouan Lt.-house	3 55	16¾	10¾
Pauillac	5 20	18½	11½
Bordeaux	6 50	18	11½
Arcachon, entrance	4 10	12¾	9¾
Adour Riv., Boucaut	3 53	8½	5½
Bayonne	3 45	12	8
St. Jean de Luz	3 6	13	9¾
Spain and Portugal.			
Port Passages	3 20	11	9
Bilbao, Bar	3 0	13	
Town	3 20	9	
Santander	3 30	15	12
Corunna	3 0	15	
Cape Finisterre	3 0		
Vigo	3 0	12-13	
Minho River	2 30	7	
Oporto	2 30	10	8
Peniche	1 54		
Lisbon Bar	2 30	12	9
Setubal	2 30	11½	7
Lagos	2 7	13	
Huelva	1 54	14	
Cadiz	1 56	12	9

Place.	High Water, Full and Change.	Rise.	
		Sps.	Nps.
	h. m.	ft.	ft.
Gibraltar, New Mole (9)	1 47	4	2½
Malaga	2 30	3	
Atlantic Islands.			
Madeira, Funchal Bay	0 48	7	
Azores, St. Michael	0 30	6	
Terceira	0 32	4½	
Fayal	11 45	4	
Canary Ids., Santa Cruz, Tenerife	1 30	8	6
Gran Canaria Id., Puerto de la Luz	0 52	10	
Cape Verde Islands, Porto Grande	6 0	3½	
Sal	7 45	5	
Mayo	6 30	5	
Bermuda, Ireland Island, Dock Yard	7 14	4	
Africa.			
Ceuta (10)	2 6	3¾	2½
Tangier	1 42	8½	5
Rabat	1 46	9-12	
Mogador	1 18	10-12	
Cape Bojador	noon	8?	
Cape Blanco	11 46	6	
Portendik	10 0	6	
Senegal River, Bar	8 42	6½	
Goree	8 8	5	
Cape Verde	7 45	8	
River Gambia	9 10	6½	5
Bijouga Ids., Orango Channel	10 0	11	
River Nunes	10 0	15	11½
Isles de Los	6 35	13-17	
Mellacoree River	7 40	11	
Scarcies Rivers	7 10	10	
Sierra Leone	7 50	12½?	
Banana Islands	8 15	9	
Sherbro River, entr.	6 0	11	
Gallinas River	6 45	4	
Monrovia	6 0	6	
Sestos Bay	5 20	4	
Cape Palmas	4 30	4	
Grand Lahou	4 20	4	
Axim	4 30	4	
Cape Three Points	4 0	4	
St. George d'Elmina	4 30	6	
Cape Coast Castle	4 30	6	
River Lagos Bar	5 0	3	
Forçados River	4 22	5	
Benin River	4 30	7	4½
Niger, Nun entrance	4 15	5	3½
Bonny and New Calabar Rivers	4 50	6	4
Opobo River	5 15	6?	5½?
Old Calabar River	5 0	6½	5
Cameroons River	5 15	7	5
Fernando Po	4 0	7	

Place.	High Water, Full and Change.	Rise.	
		Sps.	Nps.
	h. m.	ft.	ft.
Princes Island	3 58	3	1½
St. Thomas Island	3 25	4½	
Anno Bom Island	3 45	5	
Newfoundland (11).			
Quirpon Harbour	7 5	5	1¾
Canada or Canary Bay	6 46	5¼	1½
Little Bay	7 22	4½	3
Fortune Harbour	7 14	4	3
Toulinguet Harbour	7 8	4	3¼
Fogo Harbour	7 15	4½	3
Barrow Harbour	6 18	4½	2½
Bonavista	7 25	3¼	2¼
Catalina Harbour	7 0	6	4
Trinity Harbour	7 10	4	2
Hearts Content	7 33	4	2½
Carbonear	7 20	4¼	2
Harbour Grace	7 25	4¾	2
St. John's Harbour	7 30	3¾	3¼
Cape Race	7 0	6½	5
Cape St. Mary	8 30	7	5
Burin Harbour	8 45	6½	4½
St. Pierre	8 33	6½	4½
Miquelon Road	8 33	3¼	
Brunet Island	9 8	6¼	4¼
Long Harbour	8 50	7	5½
Hare Bay	8 38	7	
La Poile Bay	9 0	6	4
Codroy Road	9 15	6	4
St. George Harbour	10 3	6¾	4¼
Port au Choix	10 40	7½	
Old Férolle Harbour	9 46	5?	
Ste. Geneviève Bay	10 43	6¼	4
St. Barbe Bay	10 0	4	3
Pistolet Bay	7 39	3¼	2½
Labrador and Gulf of St. Lawrence.			
St. Lewis Cape	6 30	3½	1
Chateau Bay	7 35	3½	1
Red Bay	7 45	3½	1½
Bradore Bay	8 45	4	2
Belles Amours Bay	9 0	4½	2½
Kegashka Bay	10 45	5	3
Clearwater Point	11 30	5	3
Mingan Harbour	1 16	6	4
Bay of Seven Islands	1 40	9	5
Anticosti Id., W. pt.	2 0	6	4
East Cape	1 0	5	3
Egg Island	2 0	11	6
Magdalen River	1 15	6-8	3-4
River St. Lawrence. (12).			
Point de Monts	noon	12	6
Cape Chatte	noon	13	8
St. Nicholas Harbour	1 55	12	7
Matane River	2 15	11	7
Bersimis River	2 0	12	7
Bic Island	2 15	14	8½
Saguenay River, Tadousac	2 45	17	10
Chicoutimi	4 11	12	8
Green Island	2 45	16	9½
Brandy Pots	3 0	17	10
Orignaux Point	3 47	17½	13
Ile aux Coudres	4 25	18	13
Pillars	5 0	18	13
North Traverse	5 40	17	13
Quebec	6 49	17½	12
Port Neuf	8 30	14	9
Three Rivers	11 30	1	
Gulf of St. Lawrence.			
St. Paul Island	8 0	5	3
Magdalen Islands	8 20	3	2
Gaspé Basin	2 40	5	3
Carleton Point	3 0	6	4
Campbell Town, Ristigouche River	4 0	10	7
Miscou	2 30	5	3
Miramichi Bar	4 45	5	1¾
Richibucto River	3 30	4	2½
Point Escumenac	4 10	4	2½
Jourimain Island	9 30	6	3
Prince Edward Island.			
East Point	8 30	3½	2
Cardigan Bay	8 40	5	3¼
Hillsborough Bay	10 45	5	3¼
Charlottetown	10 45	9½	8
Bedeque Harbour	10 15	7	5
Egmont Bay	3 0	4	2
Cascumpeque Harb.	5 40	3	2
Tracadie	7 0	3½	2
St. Peter Harbour	8 30	4	2½
Cape Breton Island.			
Gut of Canso, N. entr.	9 15	4	2
Sydney Harbour	8 15	5	4
St. Anne Bay	8 34	6	4½
Louisburg Harbour	8 0	5	4
New Brunswick and Nova Scotia.			
Shediac Harbour	noon	4?	3?
Bay Verte	10 0	9	5
Wallace Harbour	10 30	8	5
Caribou Harbour	10 0	6	4
Pictou Harbour	10 0	6	4
Antigonish Harbour	9 0	4	[illegible]
Canso Harbour	7 48	6½	4½
Island Harbour	7 40	6½	5½
Ship Harbour	7 54	6½	4½
Jedore Harbour	7 45	6½	4¾
Halifax Harbour	7 49	6	5
Sable Island, S. side	6 30	4	
North side	7 30	4	

Place.	High Water, Full and Change.	Rise.	
		Sps.	Nps.
	h. m.	ft.	ft.
Mahone Bay	7 45	7½	6
Liverpool Bay	7 50	8	5
Shelburne	8 4	7	5½
Negro Harbour	8 12	7	5¾
Bay of Fundy, Nova Scotia.			
Cape Sable, Barrington Bay	8 27	8½	6½
Seal Island	9 49	12¾	10½
Pubnico	9 25	12	10
Tusket River	9 53	13	10½
Jebogue	10 4	15	11¾
Yarmouth	10 9	16	13
West Port, Grand Passage	10 43	20¾	17
St. Mary Bay, West Sandy Cove	10 47	23	19
East Sandy Cove	10 33	21½	17¾
Annapolis	11 0	30?	
Gulliver Hole	10 51	26	21½
Digby Gut	11 0	27½	23
Young Cove Point	11 14	32	28
Port George	11 17	32	28
Isle Haute	11 21	33	28½
Black Rock Lt.-ho.	11 29	36	31
Spencer Anchorage	11 42	39	33
Basin of Mines, Parsborough W. Bay	0 17	43	37½
Horton Bluff	0 30	43	40
Noel Bay	0 41	50½	43½
New Brunswick.			
Cumberland Basin, Sackville	11 55	45½	38
Cape Chignecto, Spicers Cove (13)	11 35	37	30½
Quaco	11 35	30	25
St. John Harbour	11 21	27	23
Campobello	11 21	23½	20
West Quoddy	11 12	21	17
Passamaquoddy	11 30	25	
Grand Harb., Grand Manan	11 7	21	17½
Machias, Seal Ids.	11 5	18	14¾
United States.—Portland to New York.*			
Mount Desert Id. (14)	11 18	12½	10½
Portland	11 25	9¾	8¼
Portsmouth	11 31	10	8½
Newburyport	11 31	8½	7¼
Salem	11 23	9¾	8½
Marblehead	11 16	9¾	8½
Boston Lighthouse	11 16	10	9
Navy Yard	11 36	10½	9
Plymouth	11 4	10	8½
Barnstable	11 22	10	8½
Race Point, Cape Cod	11 28	9½	8¼
Monomoy Point	12 7	4	3½
St. George Shoals	10 30	7	
Nantucket (15)	12 37	3½	3
Edgartown	12 24	2	1¾
Holmes Hole	11 43	1¾	1½
Gay Head	7 39	3¼	2¾
Tarpaulin Cove	7 59	2¾	2¼
Bird Island Light	8 3	4¼	3¾
New Bedford, entr.	8 5	4½	4
Newport	7 53	4¼	3½
Point Judith	7 40	3¼	2¾
Montauk Point	8 28	2	1¾
Sandy Hook	7 43	5	4½
New York	8 16	4¾	4
Long Island Sound.			
Throgs Neck	11 30	8	6½
Sands Point	11 13	9	7¾
Oyster Bay	11 15	8	6¼
Bridgeport	11 17	8	6¼
New Haven	11 16	6½	5¼
New London	9 37	3	2½
Stonington	9 17	3	2¼
Watch Hill	8 57	3	2½
Delaware Bay and River.			
Philadelphia	1 59	6½	5½
New Castle	12 3	7	6
Mahons River	9 19	6½	5½
Cape Henlopen	8 0	4½	3
Cape May	8 25	5	4½
DelawareBreakwater	8 24	5	4
Chesapeake Bay and River.			
Richmond	4 46	4½	3¾
James River, City Pt.	2 11	3	2¾
Baltimore	6 47	1½	1
Cape Henry	3 1	3	2½
Annapolis	4 50	1	¾
Point Lookout	1 6	1½	1¼
Cape Charles	8 11	3	2½
Old Point Comfort	8 54	2¾	2½
North Carolina to Texas.			
Hatteras Inlet	7 14	2	1¾
Cape Hatteras	9 0	5	
Ocracoke Inlet	7 14	2	1¾
Beaufort	7 31	3	2¾
Smithville	7 19	6	4¾
Cape Fear	7 0	7	
Georgetown	8 49	3¾	3½
Charleston	7 34	5¼	5
Savannah	8 22	6¾	6½

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* Chiefly from the United States Coast Survey Tide Tables, for the year 1892.

Place.	High Water, Full and Change.	Rise.		Place.	High Water, Full and Change.	Rise.	
		Sps.	Nps.			Sps.	Nps.
	h. m.	ft.	ft.		h. m.	ft.	ft.
Cape Florida	8 48	1½	1¼	Nassau, New Providence (17)	7 30	4	3
Sand Kay	8 49	1¼	1	Guinchos Kay	7 40	3	
Kay West (16)	9 39	1½	1	Clarence Harbour, Long Island	8 30	4	3½
Tampa Bay	11 6	1¾	1½	Exuma	7 20	2½	
Pensacola		2		Crooked Island	7 0	2¼	
Mobile		2		Inagua	8 0	3½	2
Mississippi, S.W. Pass		1½		San Juan, Porto Rico	8 2	1½	
Galveston		4		Mona Island	6 15	2	
Gulf of Mexico.				Virgin Islands, St. Thomas Harbour	irreg.	1	
Vera Cruz		2-4		Christianstäd, Santa Cruz..................	7 30	¾	
Triangles		1½		Anegada	9 0	1½	
Campeche	1 45	2½	2	Guadeloupe, Pointe à Pitre..............	10 0	1¼	
Cape Catouche	9 30	1½		Martinique, Fort Royal	4 0	1-1½	
Cozumel	8 30	1½		St. Lucia, Port Castries	2 36	2?	
Royal Harb., Ruatan	7 45	3½		Barbados, Carlisle Bay	3 0	3	1½
Cape Gracias Harb.	10 30	2		St. Vincent, Kingstown	8 0	1½	1
Man of War Kay ...	8 10	2		Grenada, St. George Harbour	2 40	1½	¾
Blewfields	1 50	2		Tobago	3 0	4	2
Greytown	9 0?	½-2		Trinidad, Boca Grande	3 30	4	2½
Colon		1?		Port of Spain......	4 30	4	3
West India Islands.				Icacos Point	4 14	7	4
Cuba, Havanna......	8 14	3		Gulf of Maracaibo	5 15	2½	
Bahia de Cadiz Kay	9 20	3		Cartagena	11 0	1½	1
Port Baracoa......	7 23	2		Caledonia Harbour	11 40	1½	1
Santiago de Cuba	8 30	2		Orinoco River, entr.	6 0	3	
Manzanillo.........	10 40	4		Demerara River ...	4 28	9	6
Santa Cruz.........	noon	4		Berbice	4 30	8-10	6
Port Xagua	4 57	2		Corentyn River......	5 10	8½	5½
St. Domingo, Cape Haytien	6 0	3		Surinam	6 0	9-10	5-6
Port au Prince ...	8 0?	1?		Maroni River	5 0	9	6
St. Domingo	irreg.	2?		Cayenne River	4 37	5-7	
Samana Bay	9 30?	3?					
Fort Dauphin ...	7 0	5½	3½				
Jamaica, Port Royal	11 0	1					
Grand Cayman	9 25	1½					
Gun Kay	8 30	¾					
Abaco	8 0	3					

REMARKS ON THE TIDE TABLE.

The following notes draw attention to peculiarities of the Tides as met with in various regions of the North Atlantic Ocean, of which more full and detailed accounts will be found in the Sailing Directions which accompany the Charts of the various coasts.

(1.) **River Thames.**—During strong North-Westerly gales, the Tide marks high water earlier in the River Thames than otherwise, and does not give so much water, whilst the ebb tide runs out later, and marks lower; but, upon the gales abating and the weather moderating, the Tides put in and rise much higher, whilst they also run longer before high water is marked, and with more velocity of current, nor do they run out so long or so low.

(2.) **English Channel.**—The Tides of the English Channel were but imperfectly understood till Rear-Admiral Beechey, R.N., investigated a mass of observations which had been made about the year 1847, and which demonstrated that there was a great resemblance in the characteristics of the tidal phenomena of the English and Irish Channels, and this investigation led to a more extensive series of observations throughout the English Channel, which were also discussed by Admiral Beechey. From his valuable contribution to science and the mariner, in the "Philosophical Transactions" for 1848 and 1851, we make the following extract:—

Instead of the progressive changes of stream turning progressively later as the Tide advances up the strait, they cease at a certain point, which is, in the English Channel, between the Start and Gulf of St. Malo; and in the North Sea, between the Texel and the Estuary of Lynn. Between these spots there is a Tide peculiar to the Channel, quite distinct from that of the seas on either side of it, which are always running in contrary directions.

When these streams meet, the Tide is ever varying in its direction, according as the strength of one stream prevails over that of the other, giving to the water a rotary motion, with scarcely an interval of slack water; in the space between them the Tide sets steadily *towards* Dover, while the water is *rising* there, and *away* from it while it is *falling* at that place. This "*true Channel Stream*" is about 180 miles in extent in either direction, from the point of union of the Tides in the Strait of Dover to the region of rotatory Tides off Lynn, and off the Start and St. Malo.

As the true Channel Streams are always running in opposite courses, there is necessarily a point where they meet and separate, and this occurs in the Strait of Dover. But *in this strait*, the stream, although it first obeys one tide and then another, does not slack with the Channel Streams, but is found to be still running at high and low water on the shore, at which times those streams are at rest, so that the Strait of Dover never has slack water throughout its whole extent at any time. I have, in conquence, called this an *intermediate* tide.

The limits of neither of the streams appear to be stationary, but *range to and fro* as the tide rises and falls *at Dover*, travelling to the *Eastward on both sides*, and at high and low water suddenly shifting 60 miles to the Westward to recommence their Easterly course with the next tide; and, although so far apart, they possess the remarkable peculiarity of shifting together; so that the Channel Streams preserve, as nearly as possible, the same relative dimensions.

In the Strait of Dover, this line of meeting and of separation oscillates between Beachy Head and the North Foreland, a distance of about 60 miles. When the water on the shore at Dover begins to *fall*, a *separation* of the Channel Streams begins off Beachy Head. As the fall continues, this line creeps to the Eastward; at two hours after high water it has reached Hastings; at three hours, Rye; and thus it travels on, until at low water by the shore it has arrived nearly at the North Foreland on one side of the strait, and at Dunkirk on the other. At this time the *Channel Streams* on both sides slack, but in that portion which I call the *intermediate* stream, in the Strait of Dover, the water is still running to the

Westward; and when the new *Channel* Streams make, as the water rises on the shore, this *intermediate* portion is found to unite with, or to oppose, one or the other of these streams, according as it was before the reverse; so that, as before mentioned, the line of meeting at low water appears off Beachy Head to recommence its Easterly course. This *intermediate* stream forms a remarkable feature in the tidal system of the Channel; it is well established, as the line of meeting and of separation occupies a very limited space, and it seems to be entirely due to the contracted form of the Channel in this immediate locality preventing the free escape of the water.

Admiral W. Bullock, in order to test the point of separation, anchored two vessels a mile apart, between Beachy Head and Dungeness, and found both vessels at the same time to ride with their heads in opposite directions in obedience to the streams, which were then running opposite ways.

The *Channel Stream*, which I have described as running between the intermediate stream and the rotatory or mixed streams at the outer extremities of the Channel, pursues a steady course along the main trunk of the strait, slacking only towards high and low water at Dover, when it is preparing to invert its course; and, contrary to the generally received opinion of a *progressive slack water* in a strait having a progressive establishment, this stream has the peculiarity of slacking throughout its whole extent at *nearly the same time;* and this time, as was anticipated in my former paper ("Phil. Trans.," 1848), corresponds nearly with the time of high and low water on the shore at Dover, the site of the combined wave, and the *virtual head of the tide.*

A simple rule thus suffices to guide the sailor up the main Channel Stream. It is, that *the stream runs toward Dover while the water is rising there, and away from it while falling.* The tidal hours for Dover, therefore, answer for the whole of the Channel.

The meeting of the stream off the Casquets and the Start in the English Channel, and the direction there given to the water at a particular time of the tide, will fully answer for the numerous wrecks about the Channel Islands; whilst near the Strait of Dover, an unexpected set of the stream directly down upon the Somme, and in a part of the Channel where, from its narrowness, a true stream might be expected, is evidence of the danger of approaching this part of the Channel, if ignorant of the set of the stream. And, most singularly, this occurs exactly in the spot where those disastrous wrecks of the *Conqueror* and *Reliance* took place, and where the *Curaçoa*, one of H.M. frigates, so narrowly escaped a similar fate.

Further particulars on the Tides of the English Channel will be found in the Sailing Directions accompanying the Chart.

(3.) **Southampton, &c.**—This port has the singular advantage of having two high waters, which adds not a little to its dock facilities. The same phenomenon is also found in other places within the Isle of Wight, and is owing to the Channel Tide passing round either end of the Isle of Wight, and arriving at the port at different times.

It will be observed that at Poole the rise and fall is insignificant, while on the opposite side of the Channel we have the gigantic tides of the Bay of St. Malo, a similar feature to that which is found in the Bristol Channel.

(4.) **Bristol Channel.**—The Tides of the Bristol Channel are remarkable for their magnitude and rapidity. There are few places in the world where they are exceeded. The Bay of Fundy, Nova Scotia, and the Bay of Mont St. Michel, on the French coast, are somewhat analogous. The effect of these rushing waters is to alter the channels and shift the banks in the upper portion of the Bristol Channel in a most extraordinary manner. Some idea is given in our Sailing Directions for the Bristol Channel.

Outside the Bristol Channel, spring tides rise from 22 to 24 and 26 feet; but as that channel narrows, or contracts in its breadth, the velocity and vertical rise increase in proportion; and so much that, in King Road, it rises to the height of 40 feet and upwards.* Between Nash Point and Bridgewater Bay, past Hurlstone Point, &c., the Tide sets with great velocity over the Culver Sand, into Bridgewater Bay and River. Through Caldy Sound, the stream from Caermarthen Bay makes Westward nearly two hours before the *flood* has done running without the island; and the stream makes Eastward through the sound, as well as between the Helwick Sand and Worm's Head, nearly two hours before the Channel ebb ceases.

At *Lundy Island*, ordinary spring tides rise 27 feet, equinoctial springs 31 feet, and neaps 13 feet. In *Barnstaple Bay*, ordinary springs rise 25 feet, equinoctial 28 feet, and neaps 15 feet. In this bay, at from 2 to 3 miles from shore, a gentle stream sets to the Eastward, from the time of low water to four hours flood, and then to the Westward until low water again. In mid-channel, between this bay and Lundy Island, the streams of flood and ebb set tide and tide each way, according to the time of flowing on the shore, at the rate of 3 miles an hour on springs and 2 miles upon the neaps, allowing half an hour for slacking and veering out.

It should be understood that, within the range of Swansea Bay and its offing, at about 5 miles West of the Scarweathers, the first-quarter flood sets directly toward them; after which, and until half-flood, it sweeps 1 mile outside, nearing the West end of the Nash Sands; and ultimately setting, till high water, S.S.E. by compass, which points well outside of all. It averages a rate of 4 and 5 knots on springs, and 3 knots upon neaps, and changes exactly at the same time that it ceases to rise on the shore; but slack water always lasts half an hour.

It has been observed that, over the shoals, and through the different channels, the velocity of the tides is greatly increased, and there is reason for believing that on springs the rate is nearly 6 knots.

There is always a strong tide under these shoals, which is, of course, increased or decreased according to the vertical rise. This is of consequence when working up near them, as some advantage may, in the daytime, be taken of it, by keeping on the proper side. Its influence will be manifest to any vessel thus situated, as she would nearly make her course good when under their lee, but be swept away furiously on opening the different passages. Should it be desirable to have the true tide, it will therefore be requisite to keep on the North or South side of all the shoals, according to the ebb or flood.

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* Captain Andrew Livingston, of Liverpool, to whom our earlier editions of this work were much indebted for many valuable and useful communications, informed us that he actually measured fully 50 feet rise of water, in November, 1818, at King Road, in a spring tide. At Chepstow, above, on the opposite side, the vertical rise of a spring tide also averages 50 feet, not uncommonly attaining 60 feet, and has even been known to reach 72 feet.

(5.) **St. George's Channel.**—Much that has been said of the English Channel Tides is applicable to those of the St. George's Channel, a full description of which is given in the Sailing Directions accompanying the Chart.

In the St. George's or Irish Channel, experiments have shown that, notwithstanding the variety of times of high water throughout the channel, the turn of the stream over all that part which may be called the fair navigable portion of the channel is nearly simultaneous; that the Northern and Southern streams in both channels commence and end in all parts (practically speaking) at nearly the same time; and that time happens to correspond nearly with the time of high and low water on the shore at *the entrance* of Liverpool and of Morecambe Bay, a spot remarkable as being the point where the opposite tides, coming round the extremities of Ireland, terminate. So that it is necessary only to know the times of high and low water at either of these places to determine the hour when the stream of either *tide will commence or terminate in any part of the channel.* For this purpose the Liverpool Tide Table may be used, subtracting 18 minutes from the times there given, in consequence of the George Pier being later in its high water than the point which is considered the head of the Tide.

The Tide from the Atlantic enters the St. George's Channel by two channels; of which Carnsore Point, the S.E. point of Ireland, and St. David's Head, the S.E. point of Wales, are the limits of the Southern one; and Rathlin and the Mull of Cantyre the boundaries of the Northern.

The *central portion of the stream* of flood or *ingoing* stream, runs nearly in a line from a point midway between the Tuskar and the Bishops, to a position 16 miles due West of Holyhead; beyond which it begins to expand Eastward and Westward; but its main body preserves its direction straight forward towards the Calf of Man and on towards Maughold Head. Here it is arrested by the flood or Southern stream from the North Channel coming round the Point of Ayr, and is first turned round to the Eastward by it, and then goes on with it at an easy rate direct from Morecambe Bay; thus changing its direction nearly eight points.

The *outer portions* of the stream are necessarily deflected from the course of the great body of the water by the impediments of the banks on the Irish side of the channel, and by the tortuous form of the coast on the Welsh side. The Eastern portion rushes with great rapidity between the Smalls, Grassholm, and Milford Haven towards the Bishops, which it passes at a rate of between 4 and 5 knots; sets sharply round those rocks in an E.N.E. direction, right over the Bass Bank, and into Cardigan Bay; makes the circuit of that bay, and sets out again towards Bardsey, at the other extremity of it; the streams still continuing outside towards the South Stack, which it rounds, setting towards the Skerries at a rate of upwards of 4 knots; and, finally, turns sharp round those rocks for Liverpool and Morecambe Bay; completing on its way the high water in the Menai, and filling the Dee, the Mersey, and the Ribble.

(6.) The *Western portion of the stream*, after passing the Saltees, runs nearly in the direction of the Tuskar, sets sharply round it, and then takes a N.E. ½ N. direction, setting fairly along the coast, but over the banks skirting the shore; so that vessels tacking near the inner edge of the sands on the flood, and on the outer edge on the ebb, have been carried upon them and lost, especially upon the Arklow and Codling Banks. Abreast of the Arklow is situated that remarkable spot in the Irish Channel, where the tide scarcely rises or falls. The stream, notwithstanding, sweeps past it at the rate of 4 knots at the springs, and reaches the parallel of Wicklow Head. Here it encounters an extensive projection of the Codling Bank; and while the outer portion takes the circuit of the bank, the inner stream sweeps over it, occasioning an overfall and strong rippling all round the edge, by which the bank may generally be discovered. Beyond this point the streams unite and flow on towards Howth and Lambay, growing gradually weaker as they proceed, until they ultimately expend themselves in a large space of still water situated between the Isle of Man and Carlingford. There we have not been able to detect any stream; for there another remarkable phenomenon occurs—the water rising and falling, without having any perceptible stream. This space of still water is marked by a bottom of blue mud. Such is the course of the flowing water at the Southern Channel.

In the North Channel, the stream enters between the Mull of Cantyre and Rathlin Island simultaneously with that passing the Tuskar into the Southern Channel, but flows in the contrary direction. It runs at the rate of 3 knots at the springs, increasing to 5 knots near the Mull, and to 4 knots near Tor Point, on the opposite side of the channel. The main body sweeps to the S. by E., taking nearly the general direction of the channel, but pressing more heavily on the Wigtonshire coast.

The *central portion*, midway between the Mull of Galloway and the Copeland Islands, presses on towards the Northern half of the Isle of Man; and while one portion of it flows towards the Point of Ayre, the other makes for Contrary Head, and is there turned back to the N.E. nearly at a right angle to its early course. Passing Jurby Point, it re-unites with the other portion of the stream, and they jointly rush with a rapidity of from 4 to 5 knots round the Point of Ayre, and directly across all the banks lying off there, and catching up the stream from the South Channel off Maughold Head, they hurry on together towards that great point of union, Morecambe Bay. This bay, the grand receptacle of the streams from both channels, is notorious for its huge banks of sand, and also remarkable for a deep channel scoured out by the stream, and known as the Lune Deep, which is the great haven to all vessels bound to Fleetwood, &c.

Such is a general description of the streams in the Irish Channel, which are produced by the flowing of the water, or which, for the purpose of distinction, we may designate the *ingoing streams*.

The ebbing, or *outgoing streams*, do not materially differ from the reverse of those, except that in the Southern Channel they press rather more over towards the Irish coast.

(7.) **Havre.**—Here high water remains stationary for 1^h, and only rises or falls 13 inches for the space of 3^h, much facilitating the use of the docks.

(8.) **Bay of Biscay.**—On the coasts of the Bay, the tidal wave advancing from the Westward, makes high water almost at the same hour all around its shores; and the range also does not vary greatly.

(9.) **Strait of Gibraltar.**—In the middle of the Strait of Gibraltar, the surface *current mostly* and generally sets to the East; but on each side the flood tide sets to the Westward. On the European side, West of the Isle of Tarifa, it is high water at eleven oclock, but the stream without continues to run until two o'clock. On the opposite shore of Africa, it is high water at ten o'clock, and the stream continues to run until one o'clock; after which periods it changes on either side, and runs Eastward with the general current. Near the shores are many changes, counter-currents, and whirlpools, caused by, and varying with, the winds.*

(10.) **West Coast of Africa.**—The currents on the African coast (hereafter explained) render the given times of high water uncertain.

Between Cape Cantin and Cape Blanco they are strong, and set as shown on the chart.

In the road off the Senegal, the current sets chiefly to the S.W. From the bar, strong freshes come down after the rains, and a powerful current of fresh water sets from the river to some distance out to sea.

In the Bay of Yof, to the N.E. of Cape Verde, the currents set rapidly, and sometimes in very dangerous whirls.

At the mouth of the Gambia, the greatest rise in the dry season is not more than 6 feet. Here the tide continues to run on the surface for an hour and a half after it ceases flowing on the shore.

The level of the sea, in the vicinity of Cape Coast Castle, is higher, by at least 6 feet, in the rainy season (which is the season of the strong S.W. and Southerly winds, between April and September), than in the more serene weather of the dry season.

In the rainy season, or S.W. Monsoon, trunks of trees are frequently carried on shore, and found at 6 or 8 feet above the level of the sea in the dry season. In the rainy season, also, the tides *ebb* and *flow* regularly in the several rivers; but, in the dry season, the same rivers run ebb constantly, the level of the sea being then too low to allow the tide-waters to enter their mouths.

Some remarks on the Tides about Cape Blanco, the Channels of the Bissagos, &c., are given in the Description of the Coast hereafter.

(11.) **Newfoundland.**—On the coasts of Newfoundland the Tides are very irregular, being greatly influenced by the prevailing wind. On all the Eastern coast they have nearly the same rise; springs about 6 feet, neaps 4 feet. At the entrance of St. John's they set-in in a *bore*.

Between Cape La Hune and Cape Ray the flood sets to the Westward in the offing very irregularly, but generally two or three hours after high water on shore. See more particularly our "British American Navigator," in which also will be found a full account of the Tides of the River St. Lawrence, &c., of which a condensed account follows.

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* Commander Gorringe, U.S.N., when examining the bank he discovered in 1876, lying 130 miles West of Cape St. Vincent, found the Tides setting regularly N.E. and S.W., at the rate of 1½ mile an hour. When examined by the officers of H.M.S. *Salamis*, in March, 1877, they were found to be the same.

(12.) **River St. Lawrence.**—The flood tide, entering the River St. Lawrence, proceeds upwards in the wide and deep channel of the estuary, till it is obstructed by the contracted breadth of the river near Red Island, and the sudden shallowing of it near this part; from this cause it is prevented from continuing in its upward course, and in consequence of the quantity of water here collected not finding a sufficient outlet, it is *reverted*, and forms an *eddy-flood*. The stream of flood, therefore, runs in opposite directions, on either side of the river. This stream coming from the Eastward, as it approaches the Northern part of Red Island Bank, runs very strong, sometimes at a rate of 4 knots, bearing round at this part, and proceeding in a different direction towards Razade Islands, with a velocity of from 2 to 3 miles per hour, and then proceeds onward with a constant current downwards, thus adding to the current of water from the river itself, and increasing its strength. It is strongest inshore, and extends about half-way over, diminishing in strength towards the middle; and from this difference in its velocity, and the unequal depth of the river, occasioning those violent whirls and ripples which occur in its strongest parts.

On the South coasts of that part of the river between Cape Gaspé and Green Island, there is no upward current from the tides that is available for navigation; during the floods at spring tides, there is a Westerly current felt close inshore, the line between the two streams being marked by strong rippling.

Off Point de Monts there is very little or no stream of flood, excepting close inshore, and the downward current is constant off that point. The point diverts the current to the S.S.E., which runs at a rate of from 1 to 2 miles an hour, so that it is difficult for a vessel to beat round it with a Westerly wind.

During the ebb tide the stream runs down on both sides, strongest on the South, and weakest in the middle of the estuary. On the North shore it is turned to the Southward by the projecting points at the Bay de Mille Vaches, Port Bersimis, the Peninsula of Manicougan, and Point de Monts; this fact is important, and ought to be attended to, as this Southern tendency is increased at these points, by the water brought down by the large rivers between them.

On the South side the stream of the ebb tide is also increased, by the efflux of water from the Saguenay River, which, setting with great velocity across the tail of Red Island Bank, adds to the downward course of the stream.

At 9 miles below *Tadousac*, or the *Saguenay*, is the eddy of the flood, and the stream on the surface always sets thence downward. Off Tadousac, the tide ebbs six hours eight minutes. Both streams here run three-quarters of an hour after high water. At Green Island it ebbs six hours twenty-four minutes, and flows six hours.

At the Isle aux Coudres it ebbs six hours twenty minutes, and flows six hours. Here the ebb stream continues an hour and a quarter after low water, and the flood three-quarters of an hour after high water. Within the Pillars, off St. Jean, the tide ebbs six hours fifty minutes, and flows five hours twenty-five minutes. Both streams continue to run an hour after high and low water by the shore, but they are influenced in duration by strong winds.

At the Isle of Orleans the stream ebbs seven hours, and flows five hours twenty minutes. At Quebec it flows four hours forty-five minutes only, but the ebb runs seven hours and forty minutes.

From Green Island to Quebec the Tides rise irregularly, but very considerably. From Coudre to Quebec the water falls 4 feet before the tide makes down. At the Isle of Coudre, in spring tides, the ebb runs at the rate of 2 knots; in extraordinary high tides, assisted by winds, the ebb has here been known to run quite 7 knots, and the flood 6 knots. Between Apple and Basque Isles, the ebb of the River Saguenay uniting here, it runs full 7 knots in the spring tides; yet, although the ebb is so strong, the flood is scarcely perceptible; and below the Isle of Bic there is no appearance of a flood tide.

(13.) **Bay of Fundy.**—Off Cape Sable the Tide runs at the rate of 3, and sometimes 4 miles an hour; and in the Bay of Fundy the Tides are very rapid, but uncertain both in velocity and direction. Cape d'Or and Cape Chignecto are high lands, with very steep cliffs and deep water close under them. The same kind of shore continues to the head of Chignecto Bay, where very extensive flats of mud and quicksands are left to dry at low water. Here the Tides come in a bore, rushing in with great rapidity; they are known to flow at the Equinoxes from 60 to 70 feet perpendicular; and it is remarkable that, at the same time, they rise in the Bay Verte, on the Northern side of the isthmus, only 8 feet.

(14.) **Mount Desert Rock.**—At Mount Desert Rock the stream of flood divides to run Eastward and Westward. With the Skuttock Hills about N.N.E., and within 12 or 15 miles of those of Mount Desert, the flood stream sets E.N.E., and the ebb W.S.W.; but, at the distance of 27 or 30 miles from the land, the current, in general, sets to the S.W. and more Westward. From Mount Desert Rock to the Fox Islands, at the entrance of the Bay of Penobscot, the flood stream sets W.S.W. along shore; but it nevertheless runs up to the Northward into Isle Haute Bay, &c.

(15.) **Nantucket, &c.**—Off this island and its vicinity is that remarkable but dangerous collection of shoals, which are so well known to all who navigate these waters. Their form and situation, and also the peculiarities of the Cape Cod Peninsula, lead to the inference that these characteristics are owing to some singular effect of the Tides and Currents. This subject has been partially investigated by the United States Coast Survey.

"The region about Nantucket and Martha's Vineyard is the dividing space between the cotidal hours of xii. and xv., and in this locality the combination of two apparently distinct tide-waves is observed. This combination presents the most singular forms, giving at times four high tides in one day near the junction of Nantucket and Martha's Vineyard Sounds, and distorting the tide-wave generally, not only in these sounds, but also on the open sea-coast of Nantucket and Martha's Vineyard and Islands, and in Muskeget Channel. The great disturbance of the ocean level thus produced gives rise to those remarkable currents so peculiar to this neighbourhood, and so disastrous to commerce."

(16.) **Florida, &c.**—Near Kay West, on the Florida Reef, the Tides are, in some measure, regular within the reef; the flood setting to the Westward, and the ebb contrary. To the Westward, between the Tortugas and Cayo Marques, the flood sets variably through to the Northward, and the ebb to the E.S.E.

It is remarkable that, on the South side of these kays, the flood comes from the South-Eastward; but on the North side of them, all the way from Kay West, the flood runs to the Eastward, along the edge of the bank, and to the Southward, through the little channels, in order to fill up the intermediate bays and lagoons, with the assistance of the flood from the Southward.

Westward of Kay West there is a general current to the South-Westward, along the reef, and to some distance to the South side of it.

In Chatham Bay it runs tide and half-tide; viz., three hours flood, then three hours ebb; next nine hours flood, &c. Here, in some places, it is a mere fall; but in some of the channels it is as much as four men can do to stem the current with a boat.

During a S.E. gale or storm, the water in the bays and rivers of West Florida has been known to rise 7 feet perpendicular, and vessels of burden have been driven in among the pine trees, at some distance from shore.

From Cape Roman, Northward and Westward, the tide seems to ebb and flow only once in the twenty-four hours; but it is irregular, and much governed by the winds. Yet the effects in a dry season are very perceptible in the rivers at a distance from the sea.

(17.) **Bahamas, &c.**—Although at the Bahamas the rise and fall are inconsiderable, the tide of flood sets an indraught on the Northern part of the Little Bahama Bank from every point of the compass, which renders an approach very dangerous. The tide sets with some force directly on and off the Western side of the Grand Bank of Bahama, particularly at the full and change of the moon. It is high water at half-past seven or thereabout, and the rise is 3 or 4 feet. On the Middle Ground of this bank the tides set in every direction.

In Providence N.W. Channel the current runs generally to the Eastward, about 2 miles an hour.

Near Egg Island, to the N.W. of Eleuthera, it is, however, uncertain, and great attention should be paid to the lead. In the passage within Egg Island the tide runs at the rate of 4 miles, and rises about 4 feet, the flood setting Eastward, and strongly over the reefs.

About the Berry Islands and Providence the water rises 2 feet higher when the sun comes to the Northward of the Line, than it does when the sun is to the Southward, and its strength is in a similar proportion. Here and at the Bemini Isles the flood sets to the N.E.

III.—THE CURRENTS.

(236.) **General Remarks.**—A *Current* is to be understood as a stream on, or a particular set in the direction of, the surface of the sea, occasioned by Winds and other impulses, exclusive of (but which *may be influenced by*) the causes of the Tides. It is an observation of *Dampier*, that *Currents* are scarcely ever felt but at sea, and *Tides* only upon the coasts; and it certainly is an established fact that Currents prevail mostly in those parts where the Tides are weak and scarcely perceptible, or where the sea, apparently little influenced by the causes of the Tides, is disposed to a quiescent state. This will be obvious by an attentive consideration of the following descriptions. The necessity of attention to the silent, imperceptible, and therefore dangerous operation of Currents, will be equally apparent.

(237.) The usual method of estimating the existence, direction, and velocity of a Current, is the comparison between the observed position of a ship and that obtained by dead-reckoning. It may be as well to observe in the outset, that this method of observation involves some amount of fallacy, as a Current will be the general receiver of all errors or imperfections of observation, and beyond doubt the strength of Currents has been frequently exaggerated from this very cause. Now, as the latitude is attained far more easily and accurately than the longitude, it follows that this exaggeration has been chiefly shown in those Currents supposed to move to East and West. Still, by combining a large number of observations, we may safely conclude that they will neutralize each other's errors, and afford something like an accurate conclusion.

(238.) An excellent repository of a vast number of early Current observations is found in the elaborate charts of Major Rennell, a great mine for facts in surface Current theory. Commander Maury's charts, and the more recent ones of our own and other Meteorological Offices, likewise afford a great addition to our stock of knowledge. This is also increased by numerous detached observations scattered through many works. All these, as far as attainable, were integrated at a great expenditure of labour, in the Chart of the North Atlantic Ocean, published by Mr. Laurie, which this work particularly elucidates.

(239.) But since that chart was constructed, a much more extensive series of observations has been incorporated with those just named, in a set of charts, one for each month of the year, published by the Meteorological Office in 1872. They were contained in the first 800 registers collected by that office, and were reduced by Mr. R. Strachan. In addition to these registers, the whole of the available data in Rennell's and Maury's charts were integrated with them, and thus gave a far more perfect view of the Atlantic Currents, between the Equator and 40° N., and from the African coast to the Gulf of Mexico, than was before attainable. A portion of the information then collected was shown by Admiral FitzRoy, in 1859, on the Wind Charts published by the Meteorological Department, which

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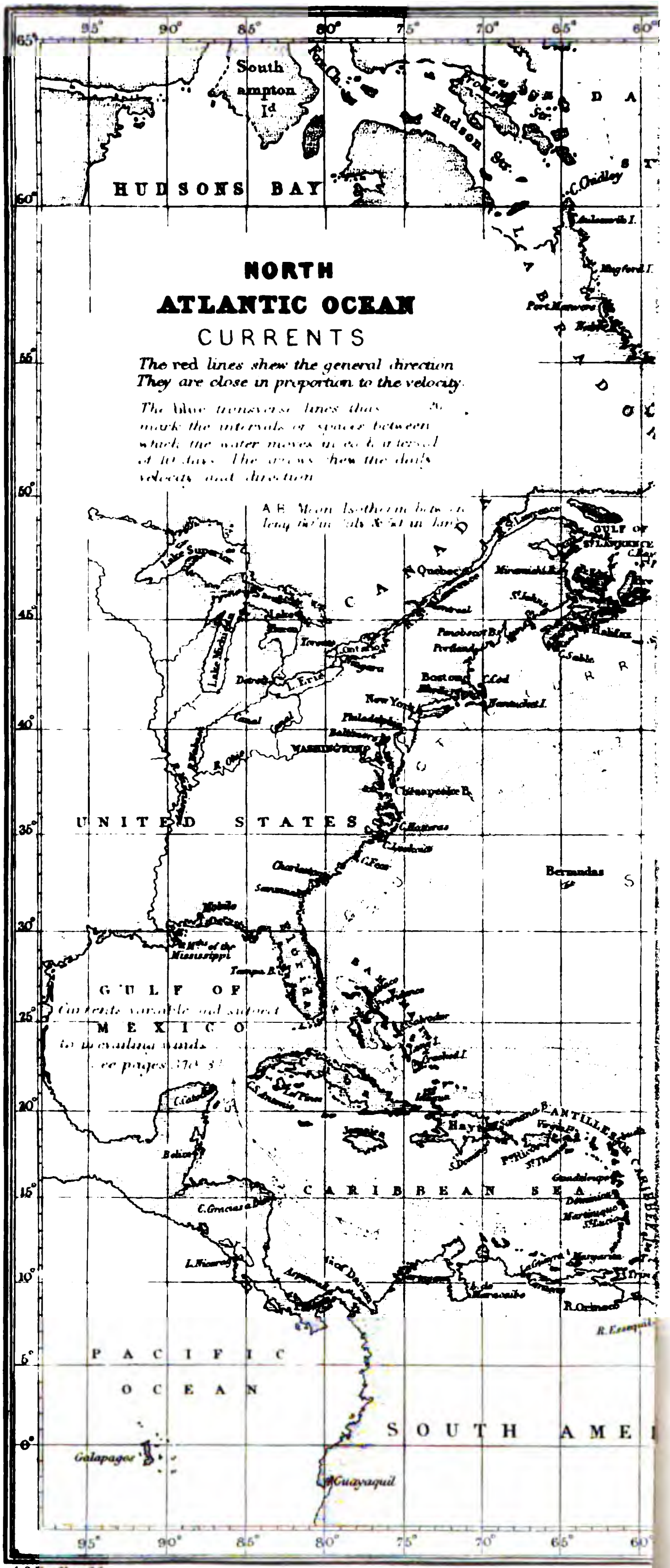

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showed the phenomena for the months of February, May, August, and November, being the middle month of each seasonal quarter.

The discussion and integration of Current observations involve a great amount of tedious labour, and there is no question but that the data used by Rennell and others required much revision, as each succeeding and better estimate gives a lower rate of progress to the movement of the surface waters, though previous discussions as to their nature have been confirmed. In the remarks on the Meteorological Office Current Charts, Mr. R. H. Scott, the Director, says:—The number of observations employed in the construction of the General Chart exceeded 7,500, each of which took 24 hours to make, so that some idea may be formed of the length of time required to accumulate them, and the great difficulty which is experienced in collecting information about Currents.

(240.) In this book, limited as it necessarily is to generalities, space could not be afforded to give the introduction of these Monthly Charts, but in the subsequent descriptions of each branch of Ocean Circulation in the North Atlantic we shall add the notes which elucidate the Current Charts, and which were also drawn up by Mr. R. Strachan.

In pursuing these calculations, it was found that in many localities the Currents were represented as most devious and erratic, frequently of great strength, and yet, on a mean, showing that there was no continued set of the waters in any special direction. The diagrams of the direction of the Wind at the Liverpool Observatory (page 203), in their more complicated parts, give a good notion of their motions, as their paths, when traced, resemble each other much. In other parts, as in the great Equatorial Current, the motion, as estimated, is remarkably uniform, and this demonstrates that these observations generally are entitled to confidence.

(241.) In founding any theories of circulation or movement of the ocean waters upon the basis of the (acknowledged to be) imperfect observations used by Major Rennell, it may be objected that many of them are now old, and therefore still less trustworthy. To this it may be replied, that they were mostly taken in *wooden* ships (with very little iron in them to affect the compasses) by careful navigators, in an age when great pains were taken with the dead-reckoning. A doubt may very fairly be expressed whether the observations of an equal number of modern ships would give as trustworthy results; their greater speed, and less attention to D.R., more refined astronomy superseding it; and errors in the compass owing to the iron used in the construction or cargo of the modern ship, all tend to give confidence in these old observations.

(242.) There is one general result in discussing any large number or collection of Current observations. They show that the surface water moves at a much lower velocity than has been attributed to Current motion generally. Perhaps this may in some degree arise from the fact that only those of remarkable strength have been selected, without properly taking into account the greater number of observations which would give a much more moderate rate.

(243.) **Bottles.**—It has been a well-known practice for many years to send these floating messengers as indicators of Currents. In 1843, Captain A. B. Becher, R.N., drew up a very interesting chart of the North Atlantic with the points of "despatch and arrival" of a very large number of these Current Bottles. The practice and the accuracy of the teaching of these Bottles led to a long controversy, which, however, did not tend to overturn their authority, so it need not be longer adverted to here, than to say that the principal objection to them was, that they were rather impelled by the prevailing Wind than drifted in the Current. But this is also a demonstration of what can be otherwise proved, that the Winds and surface Currents of the Atlantic and other Oceans obey the same laws, and move very much in the same circuits. These Bottles, then, will form an important part of the subsequent demonstrations of the direction and rate of Currents. Captain Becher's chart bears intrinsic evidence of its trustworthy character, as in each region the Bottles obey precisely the law which would, *à priori*, be laid down for them.

In July, 1891, the United States Hydrographic Office published a chart showing the tracks of a large number of Current Bottles* and Floats which had been recorded during recent years. This, also, confirms the accepted theory of the circulation of the Ocean.

(244.) Prince Albert of Monaco, assisted by Professor Pouchet, and a grant from the Paris Municipal Council, during the years 1885, 1886, and 1887, made a series of current experiments on board his sailing yacht *Hirondelle*, the results of which he communicated to the Paris Academy of Sciences, who published them in the "Comptes Rendus." He also furnished a *resumé* of them to the meeting of the British Association, at Edinburgh, in 1892, published in the "Proceedings of the Royal Geographical Society," September, 1892.†

The floats used were casks, copper globes, and bottles, weighted to prevent their being acted on by wind, and containing the usual document. In 1885, floats numbering 169 were launched along a line of 170 miles in a N. 14° W. direction from a position 110 miles N.W. of Corvo, Azores. In the next year, 510 floats were launched nearly along the meridian of 17° 40′ W., between lat. 42° 34′ and 50° N. In 1887, floats numbering 931 were launched along a line from the Azores to the Banks of Newfoundland, and 63 others in mid-Atlantic, between the Banks and the coast of Ireland.

Of these floats, 227 had come to hand again, and their tracks, as shown on the chart drawn up by the Prince, appear to confirm the usual theory of the North Atlantic Currents. From them he concludes that the mean daily velocity of the Ocean currents is as follows :—The region comprised between the Azores, Ireland, and Norway, 3·97 miles; between the Azores, France, Portugal, and the Canaries, 5·18 miles; from the Canaries to the West Indies, the Bahamas, and even to Bermuda, it attains a daily speed of 10·11 miles; and in the Eastern portion of the arc, which extends from Bermuda to the Azores, it falls again to 6·42 miles. The mean velocity which the combined results give for the surface circulation of the North Atlantic Ocean is 4·48 nautical miles in twenty-four hours.

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* Bottles used for this purpose should be painted some conspicuous colour, weighted so as to keep the corks out of the water, and securely sealed.

† Professor Pouchet published his observations in a book entitled "Courants de l'Atlantique."

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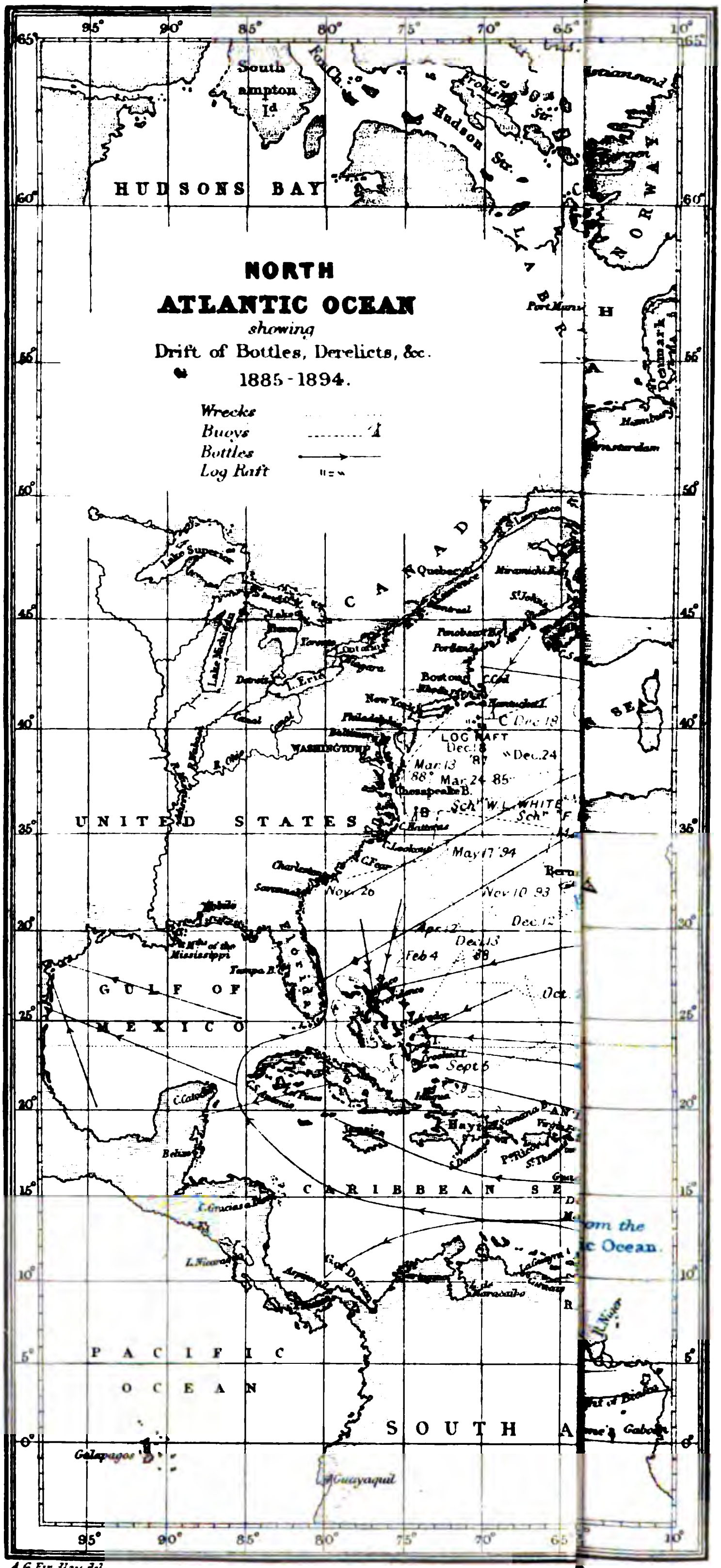

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It is apparent that circulation is more active on the Western semicircle of the vortex than on the Eastern one; and this is explained by the combined action of various causes, as the Trade Winds, the Equatorial Currents, and the Gulf Stream, also the powerful evaporation which in the Tropics stimulates the circulation of the waters.

The accompanying diagram shows graphically the drift of some of the more remarkable Bottles, Derelicts, &c., recorded in the U.S. Pilot Charts.

(245.) It may be observed that this section deals chiefly with the *Surface* Currents of the North Atlantic Ocean, as that is the only feature which affects navigation. But this superficial action is not the only point to be considered in relation to Ocean Currents, as it will not explain many phenomena known to exist. The researches carried on in H.M. Ships *Lightning* and *Porcupine*, in 1868—1870, and *Challenger*, 1873—1876, under the superintendence of Dr. Carpenter, Mr. Gwyn Jeffreys, F.R.S., and Professor Wyville Thomson, LL.D., F.R.S., together with the more recent explorations carried out by government and private vessels of our own and various other nations, have thrown much light on the temperature, condition, and probable movements of the lower beds of ocean water, which will be alluded to at the end of this work. Indeed, this may be considered as a comparatively new branch of terrestrial physics, from which many most important facts will be derived.

(246.) That the waters of the Ocean do circulate over and intermingle with every portion of the water-surface of the globe is certain. Its composition and character are everywhere, in every region, almost exactly the same. This universality of character can only be accounted for by inferring that the Ocean waters are continually being intermingled, as is the case with the atmosphere, before described (2), page 98.

It may be objected that the specific gravity of the *surface* water varies considerably in different regions, and that it is therefore an argument against this intermingling of the sea-waters. But it will be found that there are local causes which affect the saltness of the surface water. In the Arctic regions, where it is frequently found of great density, or increased saltness, it is doubtless caused by the formation of Ice, subtracting the fresh water from the surface. Again, in the Equatorial regions, it is usually found of low specific gravity, or containing less salt, which may also be accounted for by the great rain-fall which, by intermingling the light fresh water with the surface, lowers its density. Very much speculation has been used on this variation in the surface density and on its dynamic effects, in producing currents and other phenomena.

But it is deferentially urged against this reasoning, that almost all the experiments made upon the density of the water at any considerable depth (above 20 or 30 fathoms) show a remarkable uniformity in the density in all regions, varying within very narrow limits, from 1·024 to 1·028 at a temperature of 60° F., as will be shown in a later part of this book; and that, therefore, the real character of sea-water, *below* local influences, is everywhere nearly the same.

But we have remarkable proofs that not only the upper stratum, but also the whole Ocean to its bed is of one universal character. In recent deep-sea exploring expeditions, samples of water have been brought up from the greatest and intermediate depths, and on analysis the components have been found to be in all cases almost identical, the exception being that at great depths the proportion of lime is larger. Animal life, also, is found at great depths, adapted to the great pressure under which it exists. During the voyage of H.M.S. *Bulldog*, in the summer of 1860, when nearly midway between Ireland and Greenland, there were brought up from a depth of 1,260 fathoms, or nearly 1½ statute mile, several *live starfish*, which had clasped their slender arms round that part of the sounding line which lay on the bottom. Now, as the process of winding this line in would occupy upwards of an hour, had the water varied in character even in a slight degree, they would have loosened their hold and died.

It is needless to pursue this subject further now. It will be found more amplified hereafter, when the question of the Depth of the Atlantic is discussed. It is only here cited in order that should the mariner in the course of his voyage be able, from his own observations, to add to our knowledge of this subject, it will afford him great interest, and be beneficial to the rest of the world.

(247.) The subject of the *Temperature* of the Ocean will also be treated of specially hereafter. It is of importance in some localities, as it will indicate the changing from one Current to another, as from the Gulf Stream into the cold Arctic Current within it, or the reverse. It was formerly thought that a decrease of temperature was a sure indication of approaching shoal water, and its study was therefore inculcated as a precautionary measure. This point, however, has been shown to be in general fallacious. It arose from the fact that vessels crossing the Gulf Stream, or attaining soundings on the American coast, experienced a very sudden decrease of heat in the water. This is now accounted for in a very different way; therefore this topic is not of so much importance in the practice of navigation as it was formerly thought to be.

(248.) Leaving for future Sections (those on the Gulf Stream, and on the Depth, Temperature, and Circulation of the Ocean) the remarks on the origin and causes of Ocean Currents, it may be here briefly remarked that the action of the Wind seems to be a main cause of the general *surface* circulation. Doubtless there are several other forces which combine with or help to neutralize the action of the Wind, such as the Tidal Wave, the rotation of the earth, the differing effects of Temperature, of Specific Gravity on the surface, and of the very difficult subject of wave-action, which should be taken into consideration. But the tiny ripple raised by a breath of air on the surface of still water, enlarged by accumulation into an oscillating wave by a more powerful wind, may be driven forward into a wave of translation, and thus the Wind becomes the real origin of a Drift and finally a Stream Current, which may be satisfactorily traced over a great portion of the Ocean surface.

(249.) There are many evidences that the general *surface* Currents, which alone control a ship's movements, have but very little depth. A very few fathoms below the surface their velocity and power become much decreased, and it is more than probable that at a moderate depth, compared with the dimensions which have been usually attributed to them, they cease altogether, or become imperceptible to ordinary means of measurement. This has been found to be eminently the case in the experience gained in laying submarine telegraph cables. If the motion of the surface water were continued to any great depth, or if there were changeable and varying sub-surface streams, it would very greatly interfere with the success of these enterprises, but no such obstacles have shown themselves to be of any magnitude.

(250.) Of *Currents* there are two distinctions :—1. The *Drift Current ;* 2. The *Stream Current.*

The *Drift*, or *Drift Current*, is the mere effect of a *constant* or *very prevalent* Wind on the surface water, impelling it to leeward until it meets with some obstacle which stops it, and occasions an accumulation and consequent *Stream* of Current. It matters not whether the obstacle be *land* or *banks*, or a *Stream of Current* already formed. The Drift Current is generally shallow, and at a mean, perhaps, of no more than half a mile an hour, when the wind is constant and a good breeze. Such a Current, from a predominance of Westerly winds, occupies the Northern region of the North Atlantic, from the N.W. and West to the E.N.E. and S.E.; and such, likewise, is that occupying the central portion of the Ocean under the influence of the Trade Winds.

The *Stream Current* is formed by the accumulated waters of a *Drift Current*. It is more limited, but it may be of any bulk, or depth, or velocity. Of such is the temporary stream setting at times from the Bay of Biscay to the West of Ireland; and of such is the *Gulf Stream*, setting from the Mexican Sea to the Banks of Newfoundland, and terminating to the West of the Azores.

In some parts the Current is compounded of *Drift* and *Stream ;* for a Stream, already formed, may pass through the region of a prevalent wind, in a direction according with that of its Drift Current, and receive an acceleration of motion from it accordingly. Of such are the Equatorial Currents, which will be presently noticed.

(251.) The illustrative chart at the commencement of this section, page 295, will best explain the general Current system of the North Atlantic Ocean. Although this gives the mean of all observations throughout the year, and therefore would require considerable modification in various parts, if it were made to show what is to be expected at any special time or season, yet it will correctly represent that circulatory system which is found to be common to all the Oceans.

There appear to be two gyrations of the water of the North Atlantic Ocean. Around a central area, crossed by the parallel of 30° N. latitude, and termed the Sargasso Sea, the whole of the water between lat. 10° N. and 42° or 43° N., limits varying with the seasons, revolves against the apparent course of the sun. To the North of this, a portion of the water is deflected to the N.E., and revolves around some point not very far from Iceland, though some have considered that, after circulating around the Arctic basin, it re-enters the area on the West.

As the meteorological Equator, or the division between the phenomena of the Northern and Southern Hemispheres, lies to the *North* of the terrestrial Equator, we find that a reverse current, of varying magnitude and force, runs from West to East on this division, or from 2° or 3° to 8° N., across the whole breadth of the Ocean, and along the African coast; while, to the South of it, the Westerly Current of the South Atlantic runs across the Ocean and along the Northern face of the South American continent, a portion thus entering the Northern circulatory system.

There is then some difficulty in assigning a separate designation for each part of what is almost a continuous stream, and in former times when the subject was much less understood, some inappropriate terms were applied to various portions, and have become recognized and followed throughout. For the present, therefore, we are compelled to use a somewhat confused nomenclature, but it will be sufficiently explanatory till a general revision of the science may impose a new terminology.

As before stated, the charts drawn up by Mr. R. Strachan, for the Meteorological Office, will be considered as the ground-work of this section, but with some modifications of the nomenclature used.

(252.) Of the Current regions of the North Atlantic Ocean, the first in order, from the Land's End of England, is *Rennell's Current*, a temporary but extensive stream, which sets at times from the Bay of Biscay to the Westward and N.W., athwart the entrance of the English and St. George's Channels, and to the Westward of Cape Clear.

Second.—The Easterly and S.E. Currents to the coasts of Europe and Africa, and Southerly to the coast of Guinea, where it may be termed the *North African Current*, flowing to the Westward of South, and merging into the Westerly Drift.*

Third.—The *Guinea Current*, an *Easterly* stream across the Atlantic, between 5° and 8° N., and continuing along the coast of Africa, into the Bights of Benin and Biafra.†

Fourth.—The *Sargasso Sea*, or central area between the Azores, Canaries, and Bermudas, &c., in which it seems that there is no particular drift or very various and slight currents, and it is covered with the well-known Sargasso or Gulf-Weed.

Fifth.—The *North* and *South Equatorial Currents*, the vast streams caused by the Trade Winds. That of the N.E. Trade, running from between the Tropic and Cape Verde, on the Eastern side, towards the Caribbee Islands, having a general Westward tendency; and that from the S.E. Trade, which is usually found to the North of the Equator, passing strongly to the Westward, South of the counter or Easterly Guinea

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* This Southern set along the coast of Portugal and N.W. Africa is a faint converse of the Gulf Stream on the opposite side of the circulatory system. The Northern portion of it was termed by Rennell the *North Atlantic Current*, as trending from the termination of the Gulf Stream to the coasts of Europe, &c. (Investigation, &c., page 58). In the Meteorological Office Work, 1872, it is called the North African Current. For the present, the name which has been applied in former editions of this work is provisionally retained.

† Since it has been established that this Guinea Current has a different origin and character to that assigned it by Rennell and others, who argued that it was a continuation of the North African Current, the term in some degree is a misnomer. It is an Equatorial *Counter*-Current, which is found in some seasons to run across all Oceans. This origin was first intimated by the author in 1853.

Current, and then strongly to the W.N.W. along the Guayana and Colombian coasts, part joining the N.E. Trade Wind Current Northward of Tobago.

Sixth.—The *Currents* of the *Colombian* or *Caribbean Sea*, a continuation of the Great Equatorial Streams into the Mexican Sea, from the South-Eastward and Eastward.

Seventh.—The *Gulf Stream*, an outset from the Mexican Sea, setting thence to the North-Eastward, through the Strait of Florida, and thence Eastward toward the Newfoundland Banks, &c.

Eighth.—The *North-East Drift*, which passes over the Eastern side of the Atlantic, from the area East and South of the Newfoundland Banks towards and past the N.W. Coast of Europe and into the Arctic Basin.

Ninth.—The *Arctic* or *Labrador Current*, passing Southwards from Davis Strait down the coast of Labrador, round Newfoundland, and thence South-Westward past Nova Scotia and the coast of the United States inside the Gulf Stream.

In explaining this subject, we shall endeavour, in the first place, to establish the facts which prove the existence of these Currents, and then attempt to deduce the causes, according to the given description.

(253.) Masters of vessels are sometimes disappointed in not finding the expected set and velocity of the normal Currents. At times the set may be directly opposite to that looked for, or no Current at all may be found, even in the area traversed by the Gulf Stream; but these irregularities are usually of short duration, being due to abnormal meteorological conditions and other causes.

1.—RENNELL'S CURRENT.

(254.) In the *Bay of Biscay*, the prevalence of N.W., West, and S.W. winds causes a heavy swell and considerable current, needing due consideration. The waters of this gulf have a vast gyratory movement, irregular in outline, and variable in velocity, on account of the considerable effect of different winds. The S.E. current, setting on to the N.W. point of the Spanish peninsula, is divided there into two branches, one setting South along the Portuguese coast, and then turning to the Eastward about Cape St. Vincent; the other setting East along the North coast of Spain, and North along the West coast of France, where it is 15 or 20 miles across, and is felt at 30 or 40 miles off shore: it becomes wider as it proceeds Northward, and is probably joined at times by the streams from the rivers of France. On the parallel of about 48° 20′ N. it is about 80 miles across, and the set, following the coast line, is nearly W.N.W., passing 15 or 20 miles from Ushant and across the entrance to the English Channel, where it is called Rennell's Current. The commotion of the waters at the time of the flood tide in the Channel, all along the line of separation, has undoubtedly given rise to most, if not to all, the reports, formerly quite frequent, of rocks and broken water in this vicinity. It is hardly necessary to add that all search for such dangers has been unavailing.

The currents on the N.E. extremity of Spain, about Coruña, where the Eastward drift is separated into two branches by the projection of the land, are generally governed by the winds. The coast is thus dangerous in those which come from North to West, and where they are light and the sea heavy it is best to keep well off shore, otherwise the outer rocks may be passed at 2 miles distance.

To the Eastward of Cape Ortegal, and at a considerable distance from shore, but at what distance cannot be well defined, the Easterly or N.E. current is constant, and it also runs with great velocity, quite overpowering the effect of the tide. With N.E. winds, but not with others, this Easterly drift is found close inshore. The current very rarely runs to the Westward.

The drifts are more sensible to the East of Cape Peñas than to the West. They generally run to W.N.W. in the summer, and to East and E.N.E. constantly in the winter. A strong Easterly current is a sure premonitor of a N.E. gale.

On the Biscayan coast the drift is to the East during the winter season, impelled by the constant S.W. and N.W. winds.

The current frequently attains a rate of more than 3 miles an hour, when a strong gale from N.W. has occurred. A strong Easterly current during calm and serene weather is generally the precursor or indication of a gale or squall from N.W. From the same cause a very high tide may be looked for in all the harbours.

In summer the current often runs to West and W.N.W., but with little velocity, so that it may be taken almost as a general rule that the current is constantly to the East at a certain distance off the land, as before stated.

The farther you proceed up the Bay of Biscay towards Bayonne, the currents increase in strength, and turn to N.E. and North up the coast of France. Their rate is much increased by a N.W. gale, when they attain a velocity of 4 miles, and sometimes more than 5 miles an hour, according to the local seamen. The rapid drift of this Northerly current during winter gales, which always blow from S.W., will explain how the innumerable wrecks occur on the banks off Arcachon and Cape Breton.

(255.) Rennell's Current, which is occasionally of considerable breadth and strength, frequently sets athwart the entrances of the English and St. George's Channels to the N.W. and W.N.W., at some distance to the Westward of the Isles of Ushant and Scilly. As it apparently depends on temporary circumstances, it is considered as a temporary stream; and, although a certain quantity of Northerly indraught is always to be allowed for, with the tide of flood, on approaching the Scilly Islands, on the Ocean the Current, unless with particular winds, will be scarcely, if at all, perceptible.

The general causes of Currents, so far as they depend upon the state of the Winds, &c., are generally known to seamen; and that a long-continued wind, in one particular direction, will either produce a stream where no obstruction exists, or cause an accumulation of the water against an opposing coast, until a reverberation takes place, needs no demonstration. The latter appears to be the case in the present instance. A long and continual prevalence of Westerly and South-Westerly winds, in combination with a current that commonly sets into the Southern part of the Bay of Biscay, occasions an accumulation of water in the Bay, which seeks an escape, by setting to the N.W. or W.N.W.

It would be very difficult to understand that the great preponderance of winds from the Westward of North and South, which prevail in the latitudes off Cape Finisterre, should not have some effect in forcing the water toward the coast; and, if so, what can become of it, unless it forms some Current, which we should very naturally expect to find would follow the trend of the coast against which it is propelled.

That such a Current does actually prevail is too well known to be doubted. Mr. Kelly, the author of a treatise on Navigation, in two volumes, published in 1733, gave a particular instance of it (Vol. i., page 434); by which he shows that a ship becalmed with her sails furled for forty-eight hours, was in that time carried by the current 46 miles to the Northward; and we have many subsequent examples of vessels which have been set, by the course of the stream, to the Northward, or upon the rocks, of Scilly. But the writer to whom we are more particularly indebted for an elucidation of the subject, is the late Major RENNELL,* who gave an illustration of it, which placed it beyond all controversy; and from whose paper, published in the "Philosophical Transactions" of the year 1793, we extract the following observations:—

"In crossing the Eastern part of the Atlantic, the *Hector*, East India ship,

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* From the name of this gentleman, the Current is now generally denominated RENNELL'S CURRENT. The Currents of the Ocean appear to have attracted the attention of Major Rennell at an early period, and they continued to occupy his attention until the last ebb of his honourable life. The results appeared before the world in five large charts, with a descriptive volume, dedicated to his Majesty King William the Fourth, under the editorship of Mr. John Purdy, the original author of this volume.

The Major's first Chart and Remarks on the Agulhas or South African Current appeared in the year 1778, and the important pamphlet on the Scilly or 'thwart Channel Current, in the year 1793. In the meantime, and subsequently, some cursory remarks on the same subject were introduced in the "Illustration of the Geography of Herodotus," the Philosophical Journals, &c. In or about the year 1810, on the suggestion of a friend (Mr. Purdy), who expressed a wish to see all his writings on this subject combined and republished, he commenced his *Current Charts of the Atlantic Ocean*, and collected from the journals of his numerous friends a gleaning of information which, at length, from repeated accumulations, presented a most beautiful and singular instance of successful perseverance, on a subject never before attempted upon a plan so comprehensive. To an ordinary mind such a topic would have been regarded as dull, uninviting, and *impracticable*; by the author it was appreciated according to its importance and usefulness to mankind, and he treated it accordingly. He had long lamented the general ignorance prevalent on this subject, and which had, from time to time, produced so much loss of life and treasure, especially in relation to his native country. It is true that, in later times, practice and experience had taught the mariner, in many cases, how to shape his course to the best advantage; but still he was deficient in *theory*, and knew not the *rationale*, the *why and wherefore*, of the courses which he adopted, and the variations which might be most advantageously made in his outward or homeward passages, according to the fluctuations of season and circumstances. Such knowledge is now, in a great measure, supplied.

Captain Williams, in 1788, encountered, between the parallels of 42° and 49°, very strong Westerly gales; but particularly between the 16th and 24th of January, when, at intervals, it blew with uncommon violence. It varied two or more points, both to the North and S.W., but blew longest from the Northern point; and extended, as subsequently appeared, from the coast of Nova Scotia to that of Spain.

"Within 60 or 70 leagues of the meridian of Scilly, on the 30th of January, between the parallels of 49° and 50°, the effect of the Current was first experienced, which set the ship to the North of her intended parallel, by nearly half a degree, in the interval between two observations of latitude; namely, in two days. The wind, ever afterward, prevented the ship from regaining the parallel; for although the Northern set was trifling, from the 31st until she arrived near Scilly, yet the wind, being scant and light, never enabled her to overcome the tendency of the Current. It is also to be observed that the direction of the Current was much more Westerly than Northerly; the ship crossed it on so very oblique a course as to be in it a long time, and was driven, as it appears, nearly 90 miles to the West by it; having soundings in 73 fathoms, in the latitude of Scilly, and afterwards ran 150 miles by the log, directly East, before she reached the length of the Islands; running, in effect, 120 miles, and shallowed the water only 9 fathoms.

"The Current was not only sensible by the observations of latitude, but by ripplings on the surface of the water, and by the direction of the lead line. In consequence of all, the ship was driven to the North of Scilly, and barely able to lay a course through the passage between those islands and the Land's End.

"There being no timekeeper on board, the longitude was uncertain; but it was concluded that the Current, at times, extends to 180 miles West of Scilly, and runs close to the West of the islands. The breadth of the stream, where the *Hector* crossed over it, was supposed to be about 90 miles.

"A journal of the *Atlas*, East India ship, Captain Cooper, furnishes much clearer proofs, both of the existence of the Current, and the rate of its motion. This ship, outward bound, in January, 1787, had advanced 55 leagues to the Westward of Ushant, when violent gales began at South, and for four days continued between that point and W. by S.; during

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Among the names of the contributors to the work on the Currents, that of *General Edward Sabine* is conspicuous. In the year 1825, this gentleman published his *Account of Experiments to determine the Figure of the Earth by means of a Pendulum vibrating seconds in different Latitudes*, as well as on various subjects of philosophical enquiry, in which he refers to the subject of Ocean Currents in the following terms:—

"On a general review of the Currents particularized on the *Pheasant's* progress (in 1822) in her voyage, commencing at Sierra Leone and terminating at New York, it was found that she was indebted to their aid, on the balance of the whole account, and in the direction of her course from port to port, not less than *sixteen hundred geographical miles*, the whole distance being nine thousand, affording a very striking exemplification of the importance of a correct knowledge of the Currents of the Ocean to persons engaged in its navigation; and, consequently, of the value of the information in the acquisition and arrangement of which Major Rennell passed the latter years of his most useful life."

which time the ship was lying-to, with her head N.W. On the fifth day the wind abated, but was S.W.; stormy weather then ensued for nine days, the wind blowing from all points between South and S.S.W., but chiefly, and most violently, from W.S.W. and S.W.; and when the ship then proceeded Southward on her voyage, she was, by reckoning, only 2¼° of longitude West of Cape Finisterre; but, by timekeepers, more than 4¼°.

"On the day the gale commenced, the reckoning was within fourteen minutes of that by the timekeepers; the latter being more Westerly, owing to the current. On the third day after, the difference was about twenty-four minutes, when the ship was 75 miles S.W. from Scilly, in soundings of 76 fathoms. The ship, in longitude 8° 28′, had entered into the stream; and, her course being opposite to that of the *Hector*, it facilitated her progress, and carried her clear of the S.W. coast of Ireland.

"After this, in the course of fifty-one hours, the ship had set two whole degrees to the Westward of her reckoning; and in the forty-five hours following, she had a further set of twenty-three minutes; so that, in four days only, she had been carried by the Current no less than 2° 23′; and, since the gale began, 2° 32′ of longitude, or 93 nautic miles.

"It consequently appears that the *Atlas* experienced a Westerly Current, from about 72 miles W.S.W. of Scilly, to near 4° of longitude West of the meridian of Cape Clear, where its effect was imperceptible. It may, therefore, be inferred, that the stream goes off to the N.W. in the parallel of 51°; between long. 14° and 15°, and the S.W. coast of Ireland.

"No Northern set is indicated in the journal of the *Atlas*. This would have been remarkable, had the weather permitted nice attention to the reckoning; but it is to be remarked, that observations on the latitude were not regularly made; and, besides, that the great distance of 36 miles was allowed for only twenty hours' drift to the N.W., when the ship was lying-to.

"From the nature of this Current it must be obvious that its velocity will always be proportionate with the strength and direction of the wind, by which its direction will always be regulated, and that the middle of the stream will preserve its original course in a greater degree than its borders. The direction of this appears to be N.W. by W.; the Eastern border more North; and the Western more West; so that the Northerly current is stronger close to the West of Scilly than more to the Westward.

"From the foregoing observations may be deduced the following inferences:—

"1st. That ships, which cross the Current obliquely, steering a true E. by S. course or more Southerly, will continue longer in it, and be more affected by it, than those which steer more directly across it. In crossing it with light winds, the effect will be the same. Allowance must be made for the more Northerly direction of the Eastern edge of the Current.

"2nd. That, after the continuance of Westerly gales, even should a good observation of latitude be made, it would be imprudent to run Eastward from the Atlantic during a long night. For a ship might remain in the Current so long as to be drifted from a parallel, deemed a very safe one, to that of the Rocks of Scilly. It is, therefore, recommended that vessels, at such times, should keep, at the highest, 48° 45′, because in 49° 30′ the whole effect of the current may be experienced in the worst situation. But from the Current in 48° 45′, a Southerly wind will set the ship into the Channel. Coming from the Atlantic, it would be still better to make Ushant.

"3rd. That ships, bound to the Westward from the Channel, with a South-Westerly wind, so that it may appear indifferent which tack they go on, should prefer the *port* tack, as they will then have the benefit of the Current."

(256.) In a Supplementary Paper on the effects of Westerly Winds in raising the level of the English Channel, dated 22nd June, 1809, Major Rennell stated:—

"In the observations on a Current that often prevails to the Westward of Scilly, which I had the honour to lay before the Royal Society many years ago, I slightly mentioned, as connected with the same subject, the effects of strong Westerly winds, in *raising* the level of the English Channel, and the escape of the superincumbent waters, through the Strait of Dover, into the *then* lower level of the North Sea.

"The fact of the high level of the Channel, during strong winds between the West and S.W., cannot be doubted; because the increased height of the tides in the Southern ports, at such times, is obvious to every discerning eye. Indeed, the form of the upper part of the Channel, in particular, is such as to receive and retain, for a time, the principal part of the water forced in, as may be seen by the chart; and as a part of this water is continually escaping by the Strait of Dover, it will produce a Current, which must greatly disturb the reckonings of such ships as navigate the Strait, when thick weather prevents the land, or the lights of the Forelands and the Goodwin, from being seen.

"There is another circumstance to be taken into the account, which is that the *shore of Boulogne*, presenting a direct obstacle to the water impelled by the Westerly winds, will occasion a higher level of the sea there than elsewhere; and, of course, a stronger line of the Current toward the Goodwin.

"It must, therefore, be inferred, that a ship passing the Strait of Dover, at the back of the Goodwin Sands, during the prevalence of strong West or S.W. winds, will be carried many miles to the Northward of her reckoning; and, if compelled to depend on it, may be subject to great hazard from the Goodwins.

"It will be understood, of course, that although the stream of Current alone has been considered here (in order to simplify the subject), yet that, in the application of these remarks, the regular Tides must also be taken into the account. But, from my ignorance of their detail, I can say no more than that I conceive the great body of the Tide from the Channel must be subject to much the same laws as the Current itself. The opposite Tide will, doubtless, occasion various inflections of the Current, as it blends itself with it—or may absolutely suspend it; and the subject can never be perfectly understood without a particular attention to the velocity and direction of the Tides in moderate weather, to serve as a good groundwork."

(257.) After the publication of the first paper on the Currents of the

English Channel, and the supplementary paper immediately preceding, Major Rennell published some further important observations upon it, which were read before the Royal Society, April 13th, 1813, and from which the following extracts are taken :—

"During the interval of twenty-one years, since the Society did me the honour to receive my *Observations on the Current to the Westward of Scilly*, more facts relating to that Current have been collected, as well as observations on its effects, in different parts of its course, between Cape Finisterre and Scilly, the whole tending to confirmation of the general system set forth in 1793; and, in one instance, affording perhaps a clearer proof of the strength of the stream, in respect to its *Northerly* direction, than any of those adduced on the former occasion.

"In pursuing the detail of these facts and observations, I shall begin in the neighbourhood of Cape Finisterre, and proceed with the course of the Current along the Bay of Biscay; and thence across the mouth of the English Channel to Scilly, and the entrance of St. George's Channel.

"The first three facts (not detailed here) regard the Current from the open sea, setting into the South side of the Bay of Biscay, and along the North coast of Spain; which Current was supposed, in the former paper, to be occasioned by the prevalent Westerly winds, which force the water near the shore *into the bay*, and along the Southern coast of it. The water so displaced would be followed, of course, by the adjacent water *behind* it, in the open sea; and so on successively, to a certain extent. This cause must surely be referred to as the origin of the Scilly Current. The three facts converge, as it were, to one point; that is, in the proof that the waters of the Atlantic flow into the Bay of Biscay, along the North coast of Spain.

"It would seem that the North-Westerly current, by Scilly, did not, at least in many cases, balance the Easterly current round Cape Ortegal and the land of Finisterre.* The loss of His Majesty's frigate *Apollo*, with most of her convoy, may surely be attributed to the operation of this Current. Captain (afterwards Commissioner) Wallace assured me, that after having made, as he supposed, ample allowance for clearing Finisterre, yet, in the night, he had a very narrow escape from shipwreck. Very many others have been brought into the same kind of danger; so that the land of Finisterre, were it not discernible at a considerable distance, and its offing clear of rocks and shallows, and, moreover, situated in a finer climate, would prove a kind of Scilly to mariners.

"I have not been able to obtain any proofs on record concerning the course of the Current *round* the Bay of Biscay. I formerly collected some information from a French commander respecting it. He said that the setting of the Current along the coast of France, to the North and N.W., was a fact well understood, and even acted on, by many in the choice of the *tack*, on which the Current gave the greatest advantage with head winds.

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* Nor, admitting an equal rate in both places, could it well be. For the Current enters the Bay of Biscay in an *East* direction, but goes off from it *N.W.*; so that, if a ship were carried 50 miles to the N.W. from Ushant, she would only have made about 35 miles westing; but, in the other case, she would be carried the *whole* 50 miles Eastward, toward the Bay and Cape Finisterre.

"One circumstance, and that a very striking one, in respect to this particular, is, that the soundings in the Bay of Biscay show little or no *muddy bottom* to the *Southward* of the *Gironde River*, but everywhere to the *Northward*. This seems to show that the mud of the *Gironde, Charente, Loire*, &c., &c., is all carried to the Northward; and by what cause but a Northerly current? Had the motion of the sea been variable, the mud would surely have been distributed to the South, as well as to the North, of the mouth of the Gironde. The alluvial *embouchures* of the rivers in general here, and the positions of the banks formed by them in the sea, point to the North or N.W.; apparently the effect of the same sea-current."*

(258.) From experiments made by Prince Albert of Monaco, in his yacht *Hirondelle*, in the summers of 1885, 1886, 1887, and 1888, with floats of peculiar construction, he considers that during the summer there is no current setting East along the North coast of Spain, and thence to the Northward. On the contrary, his experiments show that the Current sets S.S.E. into the Bay of Biscay, and then due West along the North coast of Spain around Cape Finisterre. As before stated, there is no doubt that this Current largely depends upon the prevailing winds.

(259.) **Caution.**—Great caution is necessary when approaching the parallel of Cape Finisterre from the Northward, on account of the probable indraught into the Bay of Biscay, and no favourable opportunity should be lost for ascertaining the error, if any, of the navigating compass. Great loss of life and property annually occurs on this coast,† through vessels crossing the Bay, on their course to the Southward, trusting blindly to the course set to clear all danger, even at night, while the insidious force of the Easterly Current has set them many miles to the Eastward of their supposed position. Disasters have occurred here, both by day and night, to all kinds of vessels, from the small coaster, with its imperfect appliances, to the British man-of-war with every aid to navigation at its disposal, and this within the last few years.

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* From a view of the Chart of Soundings between Spain and Ireland, one might be led to suppose that the deep water and steep shore along the North coast of Spain had been *partly* occasioned by the water driven in from the Atlantic, in Westerly storms, along that coast; and which had gradually worn away the matter *there*, and deposited it on the bank which extends from Bayonne to the Westward of Ireland. For the bank seems to expand, as it goes Northward, in like manner as the Current; and the water is shallower than might be expected, in proportion to the depths farther in.

† During the five years 1888—1892 inclusive, 176 British merchant vessels were wrecked on the North and West coasts of Spain and Portugal.

Our readers will not fail to remember the loss of H.M.S. *Serpent*, with only three survivors out of the crew of 176. She struck at 10.30 p.m., November 10th, 1890, under Cape Villano, and at once broke up. The finding of the Court Martial which investigated the loss was, that it arose from "an error in judgment of those responsible for the navigation of the ship, in not having shaped a course sufficiently to the Westward."

In connection with this, it may be stated that H.M.S. *Lapwing*, on the following night, unexpectedly made the land near Cape Villano, having previously during the day ascertained by a momentary glimpse of the sun that the vessel *had been set* 60 *miles out of her course* into the Bay.

Again, early in the morning of February 7th, 1893, the Anchor Line steamer *Trinacria* was wrecked in the same locality, from the same cause, with the loss of thirty-four lives, only seven of the crew and one passenger being saved by swimming ashore. The vessel was on the rocks and amidst the breakers almost before those on board had time to apprehend danger.

Case after case could be recorded, showing that though the dangerous character of the current hereabout is known, due allowance for it is not always made, in some cases with fatal results. Some further remarks and cautions are given hereafter, in the Section on Passages, showing that danger might be averted by the use of the deep-sea lead.

Some have considered that these losses might be due to local attraction of the compass, but numerous observations by officers of the French navy and others have established the fact that no such irregularity in the deviation exists hereabout.

Captain C. MacMahon, of the Clan Line steamer *Clan MacArthur*, in the *Standard* of March 13th, 1893, remarks:—"The interest which has been aroused by the late wrecks about Cape Finisterre and on the coast of Portugal is, by public inquiry, demanding the cause of these disasters.

"There can be no doubt that the primary cause is bad weather and overcast sky, when crossing the Bay, preventing commanders of vessels getting sun or stars to fix their position or correct their compasses by. The secondary cause is the difference of opinion among nautical men about the amount of indraught into the Bay caused by the Easterly Atlantic current and increased by Westerly winds and gales. To this is added the leeway a vessel makes. To get an approximate value of the combined indraught and leeway is of the utmost importance. A most favourable instance occurred with this vessel on her present voyage for testing the indraught and leeway at its maximum point.

"We left Liverpool on the 16th ult. Until 6 a.m. on the 19th we had strong Southerly and South-Westerly gales, with high seas, Westerly swells, and overcast weather. The wind shifted to N.N.W. on the 19th, so that we got a good position by observation at noon, lat. 44° 24′ N., long. 9° 49′ W. From this position, a straight line due South *true* passes 23 miles West of Cape Finisterre (90 miles South) and 12 miles West of the Burlings. It was blowing a fresh gale at the time, with a high sea and Westerly swell.

"At 9.32 p.m. on the 19th, Cape Finisterre bore S. 83° E. *true*, distant 12 miles. I had allowed 8°, or three-quarters of a point, for leeway and indraught to make a *true* South course. In other words, since noon, in a 90 miles run, with an allowance of three-quarters of a point for all causes, I was set towards the land 11 miles, passing Finisterre 12 miles West instead of 23 miles. This, I think, was a fair test of the maximum indraught and leeway about Finisterre."

EXPERIMENTS ON RENNELL'S CURRENT.

(260.) *Inset into the Bay of Biscay.*—A Bottle from the *Lady Louisa*, bound to St. Michael's, in lat. 45°, long. 18° 45′, February 2nd, 1880, was found on the coast of Lit, in the province of Bayonne, October 14th, in the same year.

Channel Soundings into the Bay.—A Bottle from the brig *Hope*, from Havannah, March 31st, 1838, in lat. 50° 10′, long. 9° 48′; wind *strong from the Eastward* for three days; was found on June 1st, 1838, on the coast of Rochefort, having probably been first impelled to the S.W. by the ebb tide and prevalent wind, and thence following the general inset to the South and East.

From Channel Soundings to the West of Scotland.—A Bottle thrown from the ship *Duke of Marlborough*, Captain Jeffery, by Mr. George Thom, near the Sole Bank, in lat. 48° 38', long. 9° W., was found on the shore of Carsaig, near the middle of the South side of the Island of Mull, April 14th, 1821, and made known by Mr. Hector Maclean. At the time this Bottle was thrown into the sea, the ship was bound to London from the Cape of Good Hope, and an allowance was made for Current to the N.W. of 12 miles in the twenty-four hours. From the spot in which it was dropped, it seems unquestionable that the Bottle was carried by the Current to the West and North of Ireland, and thence between Islay and Mull, to the place in which it was found. It, therefore, well answered Mr. Thom's purpose of *confirming Rennell's Current.*

Bay of Biscay to the North of Scotland.—A Bottle, enclosing a song composed on board, from the *Great Western* steamer, on her voyage to New York, at midnight of September 10th, 1838, in lat. 48° 8' N., long. 9° 52' W., was picked up by Captain Thornton, of the *Ceres*, in passing through the Pentland Firth, on the 16th of the same month. It must, therefore, have drifted to the North-Westward and Northward, off the Western coast of Ireland, and thence to the N.E. and East, by the general drift from the Greenland Seas.

St. George's Channel.—A Bottle from the ship *Osprey*, of Glasgow, Alexander M'Gill, master, which sailed from Greenock. This Bottle (No. 310) was thrown into the sea, March 1st, 1822, on the ship's return from Calcutta, in lat. 49° 54' N., long. 12° 20' W. It was found on the shore, upon the South side of Milford Haven, on the 6th of the following month.

Easterly Current to Bristol Channel.—A Bottle from the brig *Albert*, R. L. Robertson, master, lat. 47° 20' N., long. 22° W., January 24th, 1822, on the passage from Virginia to England, the wind then about W.N.W., and had so prevailed for two or three days. Found in Rockham Bay, about 4 miles West from Ilfracombe, July 29th, 1822, and attested by the agents to Lloyd's.

Bay of Biscay, North Side.—A Bottle thrown from the ship *Graham Moore*, July 6th, 1821, in lat. 47° 47' N., long. 7° 51' W., was found September 15th, 1821, on the coast of St. Jean de Mont, arrondissement of Sables d'Olonne, department of La Vendée; and made known by the *Journal de Paris*. This bottle was impelled in an E.S.E. direction, the *North-Westerly* current not then prevailing, and was within the influence of the *Tide*.

By Captain Livingston's Journal, November 28th, 1820, "It appears that in 24 hours, ending at noon of yesterday (on the passage from Gibraltar), we made about 15 miles *North* by current; and in 24 hours, ending at noon this day, about 18 miles North, and in the two days rather more than 20' E. Therefore, about N. 40½° E., 37 miles, in the 48 hours."

Inset to, and Outset from, the Bay of Biscay.—A Bottle from the *Iris*, Captain Skinner, in lat. 47°, long. 21°, September 9th, 1802, was found at the Isle of Skye (lat. 57° 15', long. 6° 20'), February 22nd, 1803. (Probably carried into the Bay on an Eastern direction, subsequently Northward by Rennell's Current, and thence by the Eastern Drift to Scotland).

The ship *Jessie*, Bevan, master, left London for the Bahamas, about November 18th, 1833. She was struck by lightning, and abandoned by her crew, in lat. 45°, long. 14°, and on February 5th, 1834, drove on the *Isle de Groix*, near L'Orient, and was immediately dashed to pieces.

Inset; Bay of Biscay.—A Bottle from the *Carshalton Park*, Lieutenant J. Steele Park, July 27th, 1827, in lat. 48° 39', long. 10° 21', was picked up, December 21st, 1827, on the shore of Pembron Road, near the Loire, in the Bay of Biscay, lat. 47° 19', long. 2° 30' W.

A Bottle from H.M.S. *Arrow*, in lat. 48° 30', long. 9° 25', July 14th, 1838; wind from S.W. for five days, a fresh gale, and then S.W. Another Bottle from the *Maitland*, transport, in lat. 49° 5', long. 18° 19', March 10th, 1838. Both found, on the 25th of February, 1839, on the shore of Arcachon, in the Bay, lat. about 44° 40' N.

A *metal cylinder*, cast from H.M.S. *Chanticleer*, Captain H. T. Austin, May 3rd, 1831, in lat. 44° 33½', long. 11° 4' W., was found near Vivero, on the North coast of Spain, 12th of September following, at about 150 miles from the spot where it was dropped into the sea.

A Bottle from the bark *Mary*, of London, Abyah Locke, master, April 12th, 1832, in lat. 48° 30', long. 16° 56', was found on the coast of Jart, lat. 36° 25', March 4th, 1833.

Another Bottle from the same vessel, April 1st, 1832, in lat. 46° 15', long. 17° 58', was found near Cape Ferret, 44° 38', February 21st, 1833.

A Bottle thrown over from the *Wellington*, August 23rd, 1837, in lat. 45° 10' N., long. 12° 58' W., was thrown on the South coast of the Isle of Ré, probably about the end of February, 1838; found March 2nd, 1838.

Tide Water on Soundings.—A Bottle from the bark *Wallace*, of Alloa, bound to Van Dieman's Land, April 12th, 1835, in lat. 52° 18', long. 15°, was picked up at 5 miles from Ushant, August 21st, 1835.

A Bottle from the *Kent*, troop ship, in lat. 50° 20', long. 19° 0' W., August 19th, 1836, was picked up near Cape Blancnez, a few miles from Boulogne, December 20th, in the same year.

Bay of Biscay, South Side.—A Bottle from the schooner *Morning Star*, of Liverpool, Captain Andrew Livingston, October 7th, 1821, lat. 42° 45' 39" N., long. 13° 3' 21" W., was found about 22 miles to the Northward of Bayonne, lat. 43° 58' N., long. 1° 20' W., and made known in the *Moniteur* of January 24th, 1822.

One of the most singular routes of the kind that we have met with was a Bottle covered with barnacles, picked up at Mizen Head, on the S.W. coast of Ireland, October 19th, 1837. Its enclosed note stated that it was dropped off Cape Horn, from the *Salem*, R. Crukers, master, of the United States, in lat. 58° 3' S., long. 67° 5' W., on June 24th, 1830.

(261.) *Velocity.*—The daily rate of the inset into the Bay of Biscay, as estimated from the drift of the Bottles quoted in Captain Becher's chart, (243), is as follows:—(The numbers refer to Bottle Chart in the Nautical Magazine for November, 1852)—No. 2 (drifted 250 miles) 4·8 miles per day; No. 3 (230 m.) 3·3 m.; No. 3*a* (270 m.), 4·5 m.; No. 5 (420 m.), 1·8 m.; No. 11 (150 m.), 0·7 m.; No. 11*a* (100 m.), 3 m.; No. 16 (200 m.), 1·2 m.; No. 28 (700 m.), 4·5 m.; No. 28*a* (700 m.), 2·2 m.; No. 33 (650 m.), 4·1 m.; No. 37*a* (680 m.), 2 m.; No. 40 (980 m.), 3·1 m. It will be seen that the longest courses have the quickest rates, so we may suppose that when the Bottles become entangled in the shore tides and devious drifts, they do not travel so fast in direct distance. The mean rate of all these Bottles is 3·26 miles per day. The rate of those which travel up the English Channel is very much greater, averaging 11 to 14 miles per day.

The foregoing are the principal arguments and facts from which the existence of the 'thwart Channel Current is inferred. That there is some cause for the drifting of the various vessels, &c., in a Northward and Westward direction, there can be no doubt; nor can there be any doubt that the stream varies both in strength and in direction. Without enquiring into the sufficiency of the cause to produce these effects, or of the correctness of the views promulgated by Major Rennell, the foregoing remarks have been repeated, as originally given; and here we would add, that they were formed long before any correct knowledge of the Tides or of the Tidal Currents was acquired, and also that a very just estimate of the amount of derangement of the *regular Tides*, or of the set of the Current across the mouths of the English and St. George's Channels, is formed from his dissertations. The remarkable revolution of the tidal streams at the entrance of the English Channel, caused by the cross-action of that wave proceeding up the English Channel with that of the wave coming Northward, has been well developed in the observations discussed by Admiral Beechey, as stated on page 285.

2.—THE EASTERLY AND SOUTH-EAST DRIFT-CURRENTS TO THE COASTS OF EUROPE AND AFRICA.

(262.) The Currents on the shores of the North Atlantic Ocean seem to have different tendencies to the South and North of the English Channel. They are certainly very devious and uncertain; but along the West coast of Ireland and Scotland, as well as in the offing, the general set is to the *Northward*. Off the Southern part of the Bay of Biscay there is a well-marked Current to the S.E. and *Southward*, not only during those periods when the Westerly winds have been prevalent, and causing the Rennell's Current, last described, but it appears to be constantly met with; and, therefore, in sailing Southward from British ports, this tendency of the waters should be carefully considered, especially when the shores are neared, for there they run strongest.

(263.) As stated hereafter, this well-marked Current was considered to be a portion of a stream, which, running to the Southward and Eastward along the African coast to the Bight of Biafra, was the head of the Guinea Current. But in a discussion on the general system of Ocean Currents,* it was shown to be exactly analogous to an Equatorial Counter-Current, setting from East to West, between lats. 5° and 8° or 10° North, across the entire breadth of the Pacific Ocean. In an examination of the then existing data, it was found that this well-known Guinea Current was but an extension of this *Counter*-Current, which might then be traced nearly over to the American coast.

In the much more extensive series of Current observations collected in the Meteorological Office, and arranged by Mr. R. Strachan, the character of this Current is fully established in accordance with the views expressed in 1853. As the charts contained in that work* embrace a much wider range of observation than was before attainable, we shall quote on this Current, as on the other branches of the subject, the general remarks based on the results obtained for each month.

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* On Oceanic Currents, &c., by A. G. Findlay, in the Journal of the Royal Geographical Society, vol. xxiii., 1853, pages 222, 233, &c.

(264.) By a careful calculation of the Currents experienced by the ships cited in Maury's and Rennell's Charts, they appear to set with great regularity, and constantly to the South-Eastward. The experience of eighty-two ships for the year gives a mean direction and rate of 9·1 miles per day to E. 34° S., for the offing of 350 miles off Cape Finisterre and the Northern part of Portugal. The average of the months is greater than this:—January, 9·4 miles to S. 40° E.; February, March, April, 11, 15·9, and 12·8 miles per day to E. 24° S.; May, July, 12·8 and 10 miles per day to S. 25° E.; August, October, November, 20·2, 10·5, and 16·7 miles per day to S.S.E. These, compared with the drift of Bottles, show that the latter must be affected by surface causes, as their rate of travelling is much less.† All these observations are integrated on the Chart of the North Atlantic Ocean, referred to previously.

(265.) We now give the remarks drawn up by Mr. Strachan on this Current in the work before quoted, first those for the annual mean, and then for each month in succession.

The North African Current.—If a line be traced from the Azores to Madeira, and thence to the African coast, in lat. 28° N. (Canary Islands), it will be seen that to the Northward, as far as lat. 40° N., the average general direction of the Current is to the S.E., at from 3 to 12 miles a day, the rate being strongest between long. 10° and 15° W. Eastward of the 10th meridian the direction becomes more Easterly toward the Straits of Gibraltar, but counter-currents have been experienced off the coasts of Spain and Morocco. It is to be noticed that the resultant rate close to the coast of Portugal is only 1·4 mile a day, arising from the variation in direction of the observations here. South of Madeira the Current, between the coast and the 20th meridian, turns to the South, and then to S.S.W., down to lat. 10° N., its rates ranging from 3 to 13 miles per day. Between the meridians of 10° and 20° W., and the parallels of 30° and 10° N., this Current appears to slough off to the S.S.W., S.W., W.S.W., and finally merges with the Westerly drift of the North Equatorial Current about the meridian of 20° W., the rate being about 6 to 9 miles a day.

On the whole it does not appear that the waters of the North African Current mingle to a great extent with those of the Guinea Current. On the contrary, it would seem that they are finally forced towards the West by the superior strength of the Guinea Current. Even the portion of the Current which passes Eastward of the Cape Verde Islands does not appear in general to mingle with the Guinea Current. The general tendency Northward, which the Guinea Current exhibits off Sierra Leone, must lead rather to the inference that some of the water of this Current finds its way into the Westerly Drift (North Equatorial Current), mingling with the receding North African Current about lat. 10° N.

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* Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to lat. 40° N., for each month of the year.

† Estimating the set of the Current by Captain Becher's Bottle Chart, mentioned on page 295, we get the following:—Bottle No. 7 (drift 500 miles), 3·2 miles per day; No. 8, the carcase of a dead whale (220 miles), 8 miles; No. 9 (300 miles), 12 miles; No. 13 (250 miles), 4·1 miles; No. 18 (1,000 miles), 3 miles; No. 136 (550 miles), 5·5 miles per day, giving an average of nearly 6 miles per day.

Off the African coast, from 10° to 17° N., the Current is a variable one, at times setting to the Northward, fed by the Guinea Current, but more frequently to the Southward, fed by the North African Current. Here, therefore, the general rate comes out low, being from 3 to 6 miles, though the seasonal rates are much higher. Among the Cape Verde Islands the rate is also extremely trifling, and this is probably accounted for by the effect of tides upon a ship's course near the land, as sets in various directions have been reported here.

January.—The North African Current, flowing to the Southward between Portugal and long. 18° W., acquires an Easterly tendency towards the Mediterranean Sea. After passing Madeira, it flows to the Westward of South, extending to long. 25° W. in the latitude of the Cape Verde Islands, where it merges into the Westerly Drift. The portion which passes between these islands and the continent merges into the Guinea Current about lat. 10° N. The daily rate of this Current is from 6 to 18 miles.

February.—The North African Current, between the parallels of 40° and 30° N., extends from the coast to long. 18° W. Here it appears to be fed by a drift from the W.N.W., which is traceable to long. 35° W., and a tendency towards the Mediterranean is apparent. The daily rate is from 9 to 22 miles. Southward, to the 20th parallel, observations are deficient, but between 20° and 10° N. the Current, though very feeble, is still perceptible. Eastward of the Cape Verde Islands it tends towards the land while drifting onward to join the Guinea Current in lat. 10° N. Westward of these islands it soon becomes lost in the Westerly Drift. From the 20th to the 5th degrees of latitude the rate of this Current varies from 8 to 19 miles per day.

March.—The North African Current does not appear to have a decided Southerly set near the land as much as along the 20th meridian, where it travels 20 or 30 miles a day abreast Cape Verde. The Easterly tendency towards the Mediterranean is well marked at from 7 to 20 miles per day. To the North of the Canary Islands there is evidence of a counter Westerly set at the rate of 10 to 14 miles. From lat. 15° N., long. 20° W., to 5° N., 15° W., a North-Westerly set has at times been experienced of 17 to 23 miles daily, considerably stronger than the South-Easterly sets, which are reported there in this month. From 20° to 10° N., and 25° to 27° W,, the Currents appear to be uncertain, but to the Westward the Westerly Drift seems established.

April.—The North African Current exhibits more decided southing than in March, but the inset to the Mediterranean is scarcely perceptible. It extends about 10° from the land, from lat. 40° to 8° N., where it joins the Guinea Current on the right, and the Westerly Drift on the left.

May.—The tendency of the Current towards the Mediterranean is still evident, but the flow Southward is more decided than in April. From 40° N. to the Canary Islands the rate is from 7 to 21 miles. This Current extends generally about 10° from the land. South of the Canary Islands the Current tends towards the West. It mingles with the Guinea Current about lat. 7° N., and with the Westerly Drift along the meridian of 25° W., reaching as far South as 7° N. As a South-Westerly current its rate is about 12 miles.

June.—The North African Current can be traced from lat. 40° to 9° N. It still sends an Easterly current towards the Mediterranean, at a rate of 6 to 18 miles. Between the Canary and Cape Verde Islands its direction is South-Westerly, but the stream is feeble, the rate being from 6 to 18 miles. It does not pass between the Cape Verde Islands and the coast, but lies entirely to the Westward of these islands, where it soon becomes merged in the Westerly Drift. Between lats. 20° and 9° N., longs. 23° and 30° W., it is stronger than elsewhere, its velocity ranging from 8 to 19 miles per day.

In *July* the Current appears to be feeble and unsettled, and the indraught to the Mediterranean is barely traceable.

In *August* it does not seem that the Current is well maintained, nor is there decided evidence of a set towards the Mediterranean; however, the observations in this month are deficient.

September.—The North African Current can be traced to the Cape Verde Islands, but it is feeble throughout its course. Very little tendency is apparent towards the Mediterrnean; indeed, the direction of the set is sometimes opposite.

In *October* the Current reaches to lat. 10° N., but it is feeble and irregular, being best defined close to the coast.

In *November* the Current is stronger and more regular than in September and October. Off Portugal its set is E.S.E., and rate about 12 miles. It can be traced as far South as lat. 9° N.

In *December* the North African Current has become a steady flow, and can be traced at times from lat. 40° N. to 10° N. In the region of the Cape Verde Islands it loses force, and becomes less regular.

(266.) In addition to these remarks we give, as in previous editions, the particulars of various Bottles and other experiments, which are very interesting, and will be serviceable in estimates of what amount of Current may be expected in this part of the voyage.

Toward the Bay of Biscay.—The ship *Carshalton Park*, Captain J. S. Park, on returning from Jamaica to London, July, 1824, in lat. 48°, long. 18°, got into a stream setting to the Southward, and which thence operated so strongly against the ship, that some difficulty was found in getting sufficiently far to the Northward for a good Channel track. The wind shifted suddenly from S.W. to North; the vessel immediately hauled up E. by S.; and although the weather was fine, and the water quite smooth, she made no better than a true E. by N. course.*

South-Easterly Current off Channel Soundings.—In August, 1826, Captain Livingston, in the *Jane*, between lat. 48° 58′, long. 16° 7′, and Cape Clear, had a set of

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* The same ship, on the 10th of July, was on Channel soundings, the latitude by meridian altitude of the sun, 48° 53′; the longitude, by chronometer and lunar, 9° 44′ and 9° 56′ respectively, "kept the ship E. ½ S. and generally East till 11.51 p.m., when, by the moon's meridian altitude, it was found that the latitude was 49° 21′. We had

1° 14′ S. and 1° 54′ E. So that in four days the vessel was set, by a counter-current, 74 miles South and 65 miles East, or nearly S. 41° E., about 99 miles; equal to a daily average of 24¾ miles.

Off the Coast of Portugal.—A Bottle from the brig *Freeland*, Captain T. Midgley (from Liverpool to Africa), in lat. 41° 50′ N., long. 14° 23′ W., February 11th, 1833, was picked up close to the shore, off the Harbour of Vigo, on March 1st following, having traversed, in a true E. ½ N. direction, about 240 miles.

St. George's Channel to Cape St. Vincent.—On August 14th, 1823, Captain Livingston, in the sloop *Favourite*, on his passage from Liverpool to Gibraltar, took his departure from the *Smalls Lighthouse*, and thence he regularly made observations on the Current, &c., so far as adverse weather permitted. On the 23rd he had arrived on the parallel of 46° 23′; previously to which the course seems to have been materially affected by the Tide, but here the differences amounted to 51′ 55″ Southerly, and only 4′ 39″ Northerly. From lat. 46° 23′, on August 23rd, to lat. 36° 52′, on August 31st, the Current invariably predominated to the Southward, and between these parallels amounted to 89 miles in the eight days.

At 4ʰ 58ᵐ of August 31st, with Cape St. Vincent bearing true North, an excellent meridian altitude of the planet Saturn gave lat. 36° 52′ 8″. The total Southing to this point gave 2° 18′, and the difference of longitude between dead-reckoning and that by landfall gave 1° 42′ 7″ of Easting.

In the brig *Friends*, of Glasgow, August 24th, 1820, Captain Livingston states—"The current set us round Cape St. Vincent without our having seen the cape, though we steered courses for the purpose of seeing it, and we were looking out for it, when I got a lunar, and ascertained that we were then past it. Immediately after this the sea became smooth, being broken off by the cape."

Between *Cape Finisterre* and the *Azores*, the general drift of the surface of the sea appears to be to the South-Eastward; varying, however, to the East and West, and even to the Northward, as the winds operate, either one way or the other, more especially during winter, as already noticed.

H.M.S. *Pactolus*, in May, 1816, experienced a current South a little East, at the average rate of 30 miles a day, from the English Channel to St. Michael's.

Captain Charles Hare, in the brig *Ward*, from New Brunswick, September, 1823, with Westerly winds, which had prevailed for fourteen days, between lat. 43° 40′ and 45° 20′, long. 22¼° to 16°, found the current E.S.E., 1¼ mile in the hour.

Between *Portugal* and the *Western Islands.*—Captain George Cheveley, in June, 1830, lat. 44° to 27°, long. 11° to 21°, found the Current set S.E., three-quarters of a mile an hour.

The *Current* along the *Coast of Portugal* appears to set nearly in the direction of that coast. On the 25th of October, 1810, a gunboat for the service of Cadiz, being in tow of the *Rebuff* gun brig, broke adrift in a gale of wind, in lat. 39° 44′, long. 9° 38′ W. On the 19th of November following, his Majesty's sloop of war *Columbine*, when cruizing 8 or 9 miles to the Westward of Cadiz Lighthouse, observed a gunboat to leeward, which proved to be the identical boat that twenty-five days before had broken adrift from the *Rebuff*. The distance traversed by the boat was about 350 miles, or 14 miles a day, chiefly by the Current, the wind in the meantime being so various as nearly to render the drift negative, or, if anything, against the set of the Current.

On the Currents setting toward the Bay of Biscay and the Strait of Gibraltar, Captain, afterward Admiral, Sir Erasmus Gower made observations in five passages

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gone, during this interval of 11ʰ 51ᵐ, 68 miles by the log, carefully attended to, in smooth water. Now, allowing 2½ points of variation, we ought to have made 26′ of northing; whereas, in point of fact, we made 13′ only."

Influenced, probably, by the Channel ebb, the Current appeared also to have a tendency to the West.

to Madeira, from which he concluded the most general direction to be to the S.E., and the mean velocity about 11 miles in every 150 miles.*

In proceeding to Tenerife, Sir Erasmus Gower observed a constant Current setting to the Southward at the rate of a mile an hour; equal to 22 miles in the distance between Madeira and that island.

Captain Mackintosh, of the *Hindostan*, who had made twenty passages in this route, generally experienced a Current from the 39th degree of latitude to that of the Canaries. In this part of the ocean he generally found, from repeated and accurate observations, that this Current sets to the E.S.E. He found it strongest opposite to the entrance into the Mediterranean or Strait of Gibraltar; and, in one voyage, the Current was computed, by his chronometer, to set about 40 miles per day. This current inclines more Southerly as it approaches the Canaries. It strikes on the coast of Morocco, and takes, about Cape Boiador, a different direction. Nearly inshore, from an indefinite point, one part of the stream sets Northward toward the Strait of Gibraltar, and the other part sets to the Southward.

M. le Baron Roussin, in the corvette *Bayadère*, bound from Rochefort to Brasil, in February, 1819, after passing Cape Finisterre, found the prevailing Winds from noon to noon, and Currents, as follow:—

		Latitude.			*Longitude.*			*Winds.*	*Currents.*		
		°	′	″	°	′	″				
February	22 ...	42	43	38 ...	11	40	6 ...	N.—W.N.W. ...	S.S.E.	24	miles.
,,	23 ...	40	8	28 ...	13	44	17 ...	N.—N.E. ...	S.S.E.	12	,,
,,	24 ...	37	8	49 ...	13	35	30 ...	N.E. ...	S.S.E.	12	,,
,,	25 ...	34	13	11 ...	14	10	30 ...	N.E.—S.E. ...	S.E.	6	,,
,,	26 ...	31	9	17 ...	15	14	40 ...	N. and N.E. ...	S.10°E.	12	,,

But on arriving at the Canaries, with the wind North and N.E., the Current had changed.

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* The effect of a Current setting to the South-Eastward, and the necessity of a competent knowledge of Currents in general, cannot in any way be more forcibly shown than by noticing the melancholy catastrophe of His Majesty's ship *Apollo*, Captain J. W. T. Dixon, and the merchant ships under her convoy, on the 2nd of April, 1804. The *Apollo*, with sixty-nine ships for the West Indies, sailed from the Cove of Cork on the 26th of March. With a fair wind, blowing strong, they steered about W.S.W. until the 31st, when the wind changed more to the Westward. At noon, on the 1st of April, latitude observed, 40° 51′ N., longitude, by *account*, 12° 29′. At 8 p.m. the wind shifted to S.W., and increased to a gale, with a heavy sea. The convoy stood to the S.S.E., and, at half-past three next morning, struck on the coast of Portugal, in about 40° 22′ N., 9 miles to the Northward of Cape Mondego. Captain Dixon, and about sixty men of the *Apollo*, perished in their endeavours to reach the shore; the other part of the crew remained two days clinging to a fixed part of the wreck, without nourishment. About forty sail of merchantmen were wrecked about the same time; some sank with all their crews, and most of them lost several men. This lamentable event was attributed to want of chronometric observations, and the consequent ignorance of the set of the Current, which must certainly have been very strong.

"The immediate cause of the loss of so many of the *Apollo's* convoy appears to have been the blind confidence with which the commanders followed their commodore; either keeping no reckoning themselves, or believing his more accurate than their own. Several ships were saved by leaving the convoy, and it is said that the commander of a Clyde ship warned the commodore of his danger in time to have avoided it."—*A. L.*

A more recent example of the fatal effects of this current being disregarded is the loss of the Anchor Line steamer *Roumania*. On the night of October 28th, 1892, she suddenly ran aground near Peniche, on the coast of Portugal, only two passengers and six lascars saving their lives out of a total complement of 112 crew and passengers.

On the course of the same vessel, from Brest to Brasil, in October, 1821, the Current had set in the last 24 hours (October 6th), lat. 40° 24′ 36″, long. 14° 29′ 30″, S. 15° E., 20 miles; on the three following days, nearly in the same direction, but with less than half the strength. In lat. 35° 20′ 50″, long. 12° 54′ 40″, 15 miles S.E. In lat. 33° 54′, long. 12° 48′, it had set only 6 miles S. 5° E.; but, on the next day, in 34° 18′ 24″ N., and 12° 21′ W., 25 miles S. 25° E.; and again in 34° 14′ 34″ N., 12° 13′ W., South, 20 miles. Off the African coast, lat. 32° 56′ 20″, long. 13° 16′ 20″, it had set 32 miles to the S.W., or in a direction nearly parallel with the shore.

At about 222 miles W. ½ S. from Cape Mondego, on the 9th of June, 1799, M. de Humboldt, in the sloop *Pizarro*, was on his voyage to the West Indies; and, on this day, in lat. 39° 50′, long. 13° 50′, he says that they began to feel the effects of the Current setting toward the Strait of Gibraltar, &c. From the parallel of 37° to that of 30°, the vessel was sometimes carried, in twenty-four hours, from 18 to 26 miles to the Eastward. The direction of the Current was, at first, E. by S.; but nearer the strait it became due East, and it assumed a more Southerly direction on the passage towards Tenerife. "Several pilots, who frequent the Canary Islands, have found themselves on the coast of Lanzarote, when they expected to make good their landing on Tenerife."

Don Vicente Tofino sailed on the 27th of April, 1785, in the *Lucia*, from Cadiz, for Mogador, and on the 1st of May, before mid-day, arrived at the last-named port. On the 5th he sailed from it, and on the morning of the 8th anchored again in Cadiz. On his voyage out, he found that the Current, in four days, had set him 21½ miles S. 18° E., and on his return S. 49° W., 39 miles. This variation of the Current shows, that the waters throughout all this extent do not always run to the S.E., but that they vary, with the line of coast, to the South-Westward also.

H.M.S. *Pique* was once set to the S.E., 98 miles in five days, between Cape Finisterre and Madeira. H.M.S. *Raleigh*, August, 1826, found the Current from off Cape St. Mary, toward the Strait, to set W. 34° S., 26 miles in the twenty-four hours.

(267.) The following observations on the Currents between the *Canary* and *Cape Verde Islands*, are selected from Commander Maury's "Sailing Directions" 1859, vol. ii. The experience of all the ships whose logs are there recorded, is nearly unanimous in stating the Southerly and Easterly drift. Of course, the vibration of the Trade Winds with the seasons has much to do with the Southern limit of this Southerly set, as will be seen below:—

Ship *Jenny Pitts*, Captain J. L. Snow, December 27th, 1853, lat. 30° 3′ N., long. 20° 0′ W., current 8 miles S. by W.; 28th, 28° 52′ N., 18° 10′ W., 6 miles S.S.W.; 30th, 25° 26′ N., 18° 26′ W., 8 miles S. by E.; January 1st, 1854, 19° 51′ N., 22° 55′ W., 8 miles S. by E.; 2nd, 16° 42′ N., 21° 23′ W., 10 miles South; 3rd, 13° 42′ N., 22° W., 8 miles South.

Ship *Margaret Mitchell*, Captain T. Jameson, January 11th, 1854, lat. 30° 16′ N., long. 17° 35′ W., 22 miles E. by S.; 13th, 26° 7′ N., long. 20° 24′ W., S. 39° W., 14 miles; 14th, 24° 15′ N., 20° 11′ W., 12 miles E. by S.; 16th, 20° 18′ N., 20° 34′ W., 18 miles S. ¾ W.

Ship *Romance of the Sea*, Captain W. W. Henry, February 18th, 1855, lat. 30° 10′ N., long. 18° 10′ W., 1½ knot an hour N.E.; 19th, 29° 20′ N., 19° 0′ W., 1½ knot N.E.; 20th, 26° 0′ N., 19° 28′ W., 1 knot E.N.E.

Ship *Gloriana*, Captain Henry Toynbee, from London to Sydney, April 22nd, 1855, 30° 18′ N., 19° 20′ W., 12½ miles S. 5° W.; 24th, 26° 3′ N., 21° 32′ W., 8½ miles N. 25° E.; 25th, 23° 38′ N., 22° 50′ W., 4½ miles N. 12° W.; 26th, 20° 37′ N., 24° 22′ W., 6½ miles N. 15° E.; 27th, 17° 22′ N., 26° 4′ W., 9½ miles S. 57° W.; 28th, 14° 5′ N., 26° 23′ W., 16 miles S. 60° W.; 29th, 11° 12′ N., 26° 36′ W., 20 miles S. 9° W.

Ship *Resolute*, Captain D. McKenzie, June 17th, 1854, lat. 29° 54′ N., 21° 12′ W., 12 miles S. 60° E.; 19th, 26° 1' N., 24° 2' W., 12 miles S. 18° E.; 21st, 21° 44' N., 26° 22' W., 12 miles W.S.W.

Ship *Orion*, Captain H. Libbey, July 3rd, 1856, lat. 29° 5' N., long. 28° 30' W., 12 miles South.

Ship *Panther*, Captain N. G. Weeks, August 10th, 1854, lat. 28° 9' N., 22° 30' W., 12 miles W.S.W.; 12th, 28° 32' N., 25° 38' W., 15 miles W.S.W., &c. *Note.*—The ship was at this time in the N.E. Trades, which have during the summer reached to the higher latitude.

Ship *Hurricane*, Captain St. Very, August 22nd, 1855, lat. 30° 31' N., 18° 0' W., 12 miles S.W.; 23rd, 27° 11' N., 19° 15' W., 8 miles S. ½ W.; 24th, 23° 50' N., 19° 25' W., 11 miles S. by W.; 25th, 21° N., 19½° W., 6 miles S. ½ W.; 26th, 18° 4' N., 19° 45' W., 7 miles S. ½ W.

Barque *Mea*, Captain B. Buxton, August 17th, 1859, lat. 25° 41' N., 21° 14' W., 12 miles South; 18th, 23° 16' N., 22° 54' W., 8 miles South.

Barque *Adler*, Captain E. Thiel, October 27th, 1849, lat. 25° 17' N., 28° 38' W., 27 miles S. 81° W. for two days; 30th, 18° 18' N., 25° 49' W., 18 miles S.W.; 31st, 15° 45' N., 26° 35' W., 12 miles S.W. ½ W. (Trade Wind).

Ship *Colorado*, Captain Ricker, October 19th, 1855, lat. 31° 15' N., 16° 49' W., 12 miles S.E.; 20th, 28° 38' N., 18° 47' W., 24 miles S.S.E.; 21st, 26° 16' N., 20° 11' W., 12 miles S.W.; 24° 22' N., 21° 15' W., 6 miles S.W.

(268.) Mr. James Grey Jackson, in his valuable "Account of the Empire of Morocco,"* stated that the coast, between the latitude of 20° and 32° North, is a desert country, interspersed with immense hills of loose sand, which are, from time to time, driven by the wind into different forms, and so impregnate the air with sand, for many miles out to sea, as to give the atmosphere an appearance of hazy weather. Navigators, not aware of the circumstance, never suspect, during such appearances, that they are near land, until they discover the breakers on the coast, which is, in some parts, so extremely flat, that a person may walk a mile into the sea without being over the knees; so that ships strike when at a considerable distance from the beach. Added to this, there is a current, which sets in from the West towards Africa with inconceivable force and rapidity, with which the navigator being generally unacquainted, he loses his reckoning, and, in the course of a night, perhaps, when he expects to clear the African coast, in his passage Southward, he is alarmed with the appearance of shoal water; and, before he has time to recover himself, finds his ship aground on a desert shore, where neither habitation nor human being is visible. In this state his fears are soon increased by a persuasion that he must either perish in fighting a horde of wild Arabs, or submit to become their captive; for soon after a ship strikes, some wandering Arabs, strolling from their duar in the desert, perceive the masts from the sand-hills; and, without coming to the shore, repair to their horde, perhaps 30 or 40 miles off, to apprise them of the wreck, when they immediately assemble, arming themselves with daggers, guns, and cudgels. Sometimes two or three days or more elapse before they make their appearance on the coast, where they await the usual alternative of the crew either delivering themselves up, rather than perish with hunger, or throwing themselves into the sea.†

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* London, quarto, 1809. See, also, the affecting "Narrative of the Shipwreck and Captivity of M. de Brisson," in 1787; and that of Robert Adams, wrecked in the American ship *Charles*, John Horton, master, 1810. This subject is noticed more particularly in the description of the coasts of Africa, hereafter.

† Even at the present time, as more fully described hereafter, it is necessary to remember the merciless character of these Arabs. On August 20th, 1892, the Spanish trading cutter *Icod*, when anchored at Parchel, near Cape Bojador, was boarded and looted by Moorish corsairs, who carried off eleven of the crew as prisoners, the other five escaping in the cutter's boat.

The *Eliza*, commanded by John Searchwell, sailed from Cork for Rio Janeiro with settlers, on the 12th of August, 1827, and ran ashore on the coast of Africa, during a fog, on the 25th of the same month. Whilst making signals of distress, three fishing boats from Canary came to her assistance, and succeeded in saving all the lives on board, consisting of 18 mariners, 244 men, 46 women, and 42 children; in all, 350 persons, who arrived at Canary on the 3rd of September.

About the end of October, in the same year, the *Olymphe*, from Havre for Buenos Ayres, with colonists, was cast away on the same part of the African coast. The passengers, about 300 in number, consisting of French, English, Germans, and Swiss, were taken from the shore, saved from captivity by Canarian fishing-boats, and conveyed to the Grand Canary, where they were landed on the 7th of November. Such have been the effects of the Current!

(269.) The ship *Montezuma*, of Liverpool, Knubly, master, sailed on the 26th of October, 1810, from Brazil, but was wrecked on the 23rd of the next month, at 3 a.m., on the African coast, somewhere between Capes Noon and Bojador. Among the crew, who were taken and sold by the Arabs, was Alexander Scott, an apprentice. This person was detained in the country for nearly six years; and a very interesting account of his captivity, drawn up by Dr. Traill, with geographical observations on his routes, and remarks on the Currents which produced the catastrophe, by Major Rennell, were given in the fourth volume of the "Edinburgh Philosophical Journal." As these remarks give a very clear notion of the movement of the waters, derived from observation, we repeat them as heretofore.

(270). Major Rennell, in 1819, remarks on the Currents between Cape Finisterre and the Canary Islands:—"I should consider myself highly culpable if I neglected to state, by way of caution to navigators, the result of my inquiries respecting the Currents which appear to have caused the shipwreck of the *Montezuma*, and of a great number of other ships of our own and other nations, on the Western coast of Barbary, having examined a multitude of journals of ships that have sailed in that track, with timekeepers on board, and which have also, when opportunities presented themselves, had their rate checked by celestial observations.

"The general result is, that navigators who depart from the parallel of the Southern part of the Bay of Biscay (or say 45°), and sail in the usual track Southward, will be assailed first by a *S.E.* current, and then by an *Easterly* one, until they have passed the parallel of Cape Finisterre, when the Current will again turn to the *South* of *East*, and gradually become a S.E. Current, till, having passed Cape St. Vincent, it becomes Easterly again, owing, no doubt, to the indraught of the Strait of Gibraltar; and this Easterly Current is pretty general across the mouth of the bay between Cape St. Vincent and Cape Cantin.

"Beyond this bay (which may be termed the *funnel*, of which the Strait itself is the *spout*) the Current again becomes S.E., or rather more Southerly (as it is more Easterly toward Cape Finisterre), and continues as far as the parallel of 25°, and is, moreover, far beyond Madeira Westward; that is, at least 390 miles from the coast of Africa, beyond which a S.W. Current takes place, owing to the operation of the N.E. Trade Wind.

"The rate of motion of this Current varies very considerably at different times; that is, from 12 to 20 or more miles in 24 hours. I consider 16 miles as rather below the mean rate. I have one example of 140 miles in eight days, in one of His Majesty's ships, equal to 17½ miles per day; and, in another, of only 12 miles; and in a very well kept East India ship's journal, 170 miles in nine days to Madeira, or 19 miles per day. The direction of the stream likewise varies, but is commonly more toward the *South* than the East, after passing the mouth of the Strait.

"Near the coasts of Spain and Portugal, commonly called the Wall, the Current is always very much Southerly, owing, perhaps, to the falling in, obliquely on the shore, of the great mass of water brought by the S.E. Current; which can run off only toward the South, and round Cape St. Vincent toward the Strait's mouth. Amongst the Canary Islands, and between them and the coast of Barbary, the Currents are less regular.

"It may be taken for granted that the whole surface of that part of the Atlantic Ocean, from the parallel of 40° to 45° at least, and to 300 to 400 miles off shore, is in motion toward the mouth of the Strait of Gibraltar.

"According to what has been said, in the course of the above remarks, it must be expected that a ship, sailing in the usual track to Madeira or the Canaries, will be carried to the *South-Eastward*, at the rate of 16 miles per day; that is, even if she has a fair wind, she will be carried by the Current 150 or 160 miles to the South-Eastward, in the course of a voyage to Madeira or the Canaries; and, consequently, on a *S.E. by S.* course, will be carried 80 or 90 miles to the Eastward of her intended port. If we suppose a *S.E.* course, the error in easting will be no less than 109 miles; which distance, if they are bound to Tenerife, would carry them to Allegranza or Forteventura; and, if intending to make Allegranza, would place them on shore on the coast of Barbary. The French and Spaniards report that their ships have often made Allegranza when they supposed themselves on the line toward Tenerife. It must be added that, if a ship had a long passage, the error would be greater in proportion, and might possibly amount to 200 miles of easting.

"It would seem advisable, therefore, that every ship going to the Canaries, or intending to sail between those islands and the mainland of Africa, if without timekeepers, should, to every day's reckoning, *add ten miles of easting*. This would, in the first instance, prevent them from *deceiving themselves* as they went forward; in like manner, as it is better to set a clock forward at once, than to charge one's memory continually with its being too slow. *Ten miles* does not seem too much as a cautionary measure, as a ship has very lately been carried 99 miles to the *East* in eight days in that track. What would not have been the error had she had even a moderately long passage?"

The preceding description of the Currents between the English Channel and the Canary Islands was corroborated, 1826, by Captain R. H. Newby, in the *Napoleon* schooner, which left Dartmouth on the 21st of July, and was set to the Eastward of her reckoning, while crossing the Bay of Biscay, 1° 21′ of longitude in 48 hours. On Monday, the 25th of the same month, the entrance of Ribadeo bore S.W. by compass, about 15 miles, and the vessel was then in about 6° 55′ W.

The effect of the Easterly Current was proved by the bearings of a remarkable mountain inland, and some whitish cliffs on the shore; and Captain Newby says, the schooner was setting to the Eastward as fast as he had noticed a ship to lose ground to the Eastward while standing inshore of Beachy Head during a strong flood tide and moderate Westerly breeze. At about 5 p.m. the wind veered to the N.E., and even then, although the vessel was going at the rate of 3½ knots through the water, she made very little way to the Westward till toward sun-down, when the breeze freshened to 7 or 8 knots. During the night, passed Cape Ortegal; and the next morning, at 6 a.m., the light tower at the entrance of Coruña bore South.

Upon going over the two days' work, July 27th and 28th, it appeared that, instead of passing, as supposed, to the Westward of Madeira, the *Napoleon* was actually out of sight of the island to the *Eastward;* and had the vessel been involved in fog, or have been bound to Lanzarote or Fuerteventura, and steering, by reckoning, a fair course for them, the consequence must have been that she must have fallen into broken water when least expected, or have grounded on the mainland, somewhere between Cape Ghir and Cape Noon, and property, if not life, would have been lost.

(271.) **Coasts of Spain and Portugal.**—Besides the Northern branch of the Atlantic Easterly drift which sets into the Bay of Biscay, there is a Southern branch, which from Cape Ortegal turns gradually to the S.E. and Southward along the coast, and, after passing Cape St. Vincent, sets Eastward towards the Strait of Gibraltar. This is in ordinary weather, but with strong Westerly winds it sets towards the land, and this unsuspected drift has led to the loss of numerous vessels, as detailed previously on page 317. With strong Southerly winds, the current may be found setting Northward.

Due attention to the soundings, when the position is uncertain, should keep a vessel clear of danger along this coast, bearing in mind the Easterly onshore current usually accompanying N.W. and Westerly winds, and the effects of the heave of the sea affecting the steering.

(272.) The following remarks on the Currents on the Western coast of the Spanish Peninsula are given in the Anuario Hidrografico for 1867 :—

On the Western shore of the Peninsula the Currents are strong, and in its immediate neighbourhood run from South to North, and North to South, according to the prevailing wind. But in the offing they incline to the N.E. or S.E., according as the wind may be S.W. or N.W. Against these onshore winds vessels must therefore take precaution, for if the S.W. wind is blowing, or even the N.W. also, the vessel will drift to the shore. Experience has shown that allowance must be made for drift by steering more Westerly courses than the lay of the coast would require to keep clear of it, especially when it is blowing hard.

It is observed on the coast of Galicia, and the same would naturally occur on the coast of Portugal, that, on one or even two days previous to a gale, the Current sets towards that point of the horizon from which it will eventually come; that is, when the Current sets to the South without any apparent cause, the Vendaval (144) will come in a gale, and a similar result follows when the Current sets to the North. So that the fishermen, who have most to do with allowing for Currents, know very well by them when a N.E. or S.W. wind is about to set in.

The Current generally produced by the wind sets to the N.E. and North, when that is from any point between South and West, and it sets to the South when the wind is anywhere between West and East from the Northward. In winter, the Current sets mostly from some point between North and East, and in summer from some one between North and West; and its hourly rate is about 2 miles, and even more, with a strong Vendaval.

The navigator who finds himself off Cape Finisterre with a Vendaval to beat against, must be careful of the shore in bad weather, for he will be drifted insensibly to leeward until he has passed Cape Prior.

With respect to ships off Cape St. Vincent, bound towards Cape Finisterre with fresh N.E. winds, they will find enough to do, to overcome the Current they will meet with along the coast. And with fresh N.W. or S.W. winds there is also a rise in the level of the sea, in all the estuaries and ports of the Peninsula, the reverse of what takes place at Cadiz and in the Bay of Biscay with N.E. winds.

(273.) THE BARON ROUSSIN'S REMARKS ON THE CURRENTS BETWEEN CAPE BOJADOR AND THE ISLES DE LOS.

The general Currents on the African coast, between Cape Bojador and the Isles de Los, with the exception of some places subject to a more or less regular tide, are uniform during the eight months which comprise the fine season. They follow exactly the trend of the coast from North to South.

From Cape Bojador to the Bay of St. Cyprian (lat. 22° 20′) they therefore set to the S.S.W.; from that bay to Cape Blanco, and along the whole extent of the Bank of Arguin to its Western point, which is in the parallel of 20° 6′ 20″ N., they set S. by W. To the Southward of this point the waters, being no longer guided by the edge of the bank, which turns abruptly to the S.E., do not follow in a body, within a certain space, any fixed or determined direction. One part of their mass experiences a number of irregular windings, until, finding itself in the active body of the general Current, which left the bank at its most salient point, it rejoins it, and is carried on as before.

In the vicinity of Tanit Bay, in the parallel of 19° 10′ N., it again resumes its former direction, and follows the trend of the coast, thus setting to the Southward as far as near Portandik, and from thence S.S.W. to the Marigot of Musquitos. It then sets S. ½ W. till abreast of the Bar of the Senegal, where, in a space of 12 miles in circumference, it is disturbed by the stream of that river. This stream is so strong as to oblige vessels at the anchorage off the bar to trend to it, in spite of the strongest winds. The Current, joined by the waters of the Senegal, pursues its course along the coast, which trends to the S.W., observing a very gentle curve, which forms the Bay of Yof, and which terminates at Cape Verde. The strong Currents hitherto pretended to set into the Bay of Yof are, therefore, merely chimerical. Cape Verde being the most Western point of Africa, and hence forming an obstruction to the general direction of the waters which flow along that coast, must occasion a great variety of Currents in its vicinity. This is, in fact, what takes place, and it would, therefore, be difficult to define a particular one. This only appears certain: vessels passing in sight of Cape Verde are not carried on it, as is generally supposed; but, on the contrary, they are swept off by the prevailing tendency which the waters have to flow to seaward. In running close to Almadie Rocks, this repulsion is sensibly felt during the eight months which I have mentioned. It appears that the Current rushes between the rocks, and spreads itself in different directions.

Immediately to the Southward of Cape Verde the Current is almost imperceptible, and it is scarcely possible to assign any particular direction to it as far as Cape Naze. The whole of the coast lying between this cape and Cape Manuel forms a well defined bay, totally free from Current, and in which there is not a single river. The same is observed with respect to the roadstead of Goree, although, according to the observations of Mr. Adanson, a regular tide exists there, with a rise and fall of 2½ feet. In the offing of Cape Verde the Current has been always found to set to the Southward. From Cape Naze it again follows the direction of the coast, interrupted only at the mouths of the principal rivers, which lie between this cape and Cape Roxo. From this point, localities of a very different nature produce particular effects in the Current. The Archipelago of the Bissagos here succeeds the straight coast which extends to the Northward. Large rivers empty themselves amongst these islands, forming various channels, more or less encumbered with sand-banks. These obstacles cause a variety of Currents, which will be explained when treating on the Bissagos.

Strength of the General Current.—The rate of the general Current on the African coast, deduced from numerous observations, has never exceeded 1½ mile per hour on the coast itself, and on the outer edge of the banks; and more frequently it has been found from seven to nine-tenths of a mile. This is diminished one-third, and frequently one-half, at a distance of 12 miles from the coast. Should a sailing vessel have run past her port, there is no fear of her not stemming this Current, and, by long boards, easily regaining her destination.

In the Rainy Season, which is from the commencement of June to the end of October, as the wind blows from various directions, the Currents are no longer regular, and it is impossible to establish any positive law respecting them; but, even under these circumstances, their strength is not so great but that it may be surmounted.

3.—THE GUINEA CURRENT.

BEING AN EASTERLY STREAM ACROSS THE ATLANTIC, AND ALONG THE COAST OF AFRICA, INTO THE BIGHTS OF BENIN AND BIAFRA.

(274.) In the description of the Winds (6), page 99, and (80, 81), page 157, and in the diagram illustrating the Best Monthly Routes Across the Equator, it is shown, that between the N.E. and S.E. Trade Winds there is a Belt of Calms and Variable Winds, which, on the African coast, assume the character of monsoons, as, during the summer months especially, the wind blows more or less toward the African coast.

In the Currents there appears to be an analogous system, as there is an *Easterly* Current flowing with considerable velocity Eastward, in an opposite direction to the great Equatorial Drifts on either side of it. Its existence and character along the Guinea Coast has been long known. It was formerly thought to be a continuation of that Current which we have just described as passing Southward from Western Europe, but later investigations seem to point to the fact that it is a flowing back of the waters heaped up to the Westward by the prevalent winds. In tracing the Currents of the Pacific Ocean,* we find that there exists a precisely similar Current in that great ocean setting into the Bay of Panama, in the same latitude. This Current is traced very far to the Westward—in fact, nearly across the ocean.†

(275.) Commencing with the ordinary Westernmost part traversed by vessels crossing the Equator, we select from Commander Maury's Sailing Directions the following facts:—

Captain H. T. Walter, barque *Phantom*, says:—In July, 1853, between lat. 5° and 8° N., and about long. 36° and 38° W., the Current set us fast to the Eastward. Again, in August, 1854, about the same latitude and longitude, the Current set us 110 miles N.N.E. in three days. Capt. Millet writes:—December 25, 1855, lat. 4° N., long. 29° W., have experienced an Easterly Current these last two days. I have always noticed such along these latitudes, sometimes more to the Northward than this, and in lat. 1° N., and long. 44°.

We have here examples at opposite seasons of this Current in the Western crossing of the Atlantic.

Ship *James Brown*, Captain C. W. Kerlin, January 12, 1856, lat. 8° 43′ N., long. 31° 37′ W.; current 20 miles Easterly. 13th, lat. 5° 30′ N., long. 30° 21′ W., 28 miles Easterly. Crossed the Equator on the 16th, and experienced no Westerly Current.

Ship *Margaret Mitchell*, Captain T. Jameson, January 23, 1854, lat. 4° 36′ N., long. 22° 25′ W., 13 miles E. by S. 24th, lat. 3° 1′ N., long. 22° 30′ W., S. by E. 20 miles.

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* See Directory for the North Pacific Ocean, by A. G. Findlay, and also Journal of the Royal Geographical Society, vol. xxiii., pp. 222, &c., as before quoted on page 312.

† The non-continuity of this Guinea Current with that which flows Southward from Portugal and N.W. Africa, the North African Current, was demonstrated by the author many years ago, and its analogy with the Equatorial Counter-Current in the Pacific, and also with a periodical Easterly Current in the Indian Ocean.

Ship *Gravina*, Captain C. Sprague, March 4, 1855, lat. 2° 48′ N., long. 26° 46′ W., S. 34° E. 17 miles. 6th, lat. 1° 22′ N., long. 27° 43′ W., 12 miles N. by E.

Barque *Eglantine*, Captain Gleason, April 7, 1855, lat. 11° 28′ N., long. 24° 25′ W.; Current setting to Eastward, though the ship was steering S. by W. ½ W.

Ship *Mary L. Sutton*, Captain P. E. Rowland, April 24, 1856, lat. 16° 4′ N., long. 33° 30′ W.; Current East 45 miles. 25th, lat. 12° 40′ N., long. 32° 32′ W., East 10 miles. 26th, lat. 9° 22′ N., long. 31° 20′ W., East 10 miles. (This is more to the Northward than usual).

Ship *Aetos*, Captain D. McLaughlin, May 18, 1856, lat. 5° 48′ N., long. 24° 44′ W., 24 miles E. by N. 19th, lat. 3° 39′ N., long. 24° 10′ W., 14 miles E.N.E. 20th, lat. 2° 56′ N., long. 24° 0′ W., 15 miles E.N.E. 21st, lat. 2° 15′ N., long. 23° 34′ W., 15 miles E.N.E. 22nd, lat. 1° 20′ N., long. 25° 15′ W., 10 miles N.E.

Ship *Edwin Flye*, Captain W. Flye, June 27, 1856, lat. 5° 38′ N., long. 26° 17′ W., N. 8° E., rate 1·2 mile per hour. 28th, lat. 4° 45′ N., long. 27° 29′ W., N. 18° E., 1 mile per hour. 29th, lat. 3° 52′ N., long. 25° 12′ W., N. 22° E., rate 1·3 mile per hour.

Ship *Panther*, Captain N. G. Weeks, August 19, 1854, lat. 7° 57′ N., long. 25° 54′ W., 24 miles E. by S. 20th, lat. 6° 55′ N., long. 23° 28′ W., N.E. ¾ E. 48 miles. 21st, lat. 5° 41′ N., long. 20° 30′ W., 48 miles N.E. by E. ¾ E. 22nd, lat. 4° 56′ N., long. 18° 7′ W., E. by N., 1·2 mile per hour. 23rd, lat. 2° 41′ N., long. 20° 4′ W., 1 mile per hour S.E. by S.

Barque *Mea*, Captain B. Buxton, August 27, 1849, lat. 5° 57′ N., long. 19° 32′ W., half knot per hour N.E. 28th, lat. 4° 12′ N., long. 17° 33′ W., half knot N.E. 29th, lat. 4° 0′ N., long. 19° 47′ W., 6 miles E.N.E. in the day.

Brig *Director*, Captain Skinner, writes:—"You perceive that I had a strong Current between lat. 7° and 5° N., on September 7—10. Not getting an observation for four days, I found the brig nearly 3° farther East than I expected; whether I had it in one, two, three, or on the fourth day, I cannot say, but suppose I had some each day. I was speaking with several captains, and they say that they have always found a strong Current about them going to the Eastward."

Captain Maury adds:—"An Eastwardly Current is often found North of the Line in summer and fall; and at those seasons it may be counted on with some degree of certainty." (This refers to the Western crossing of the Equator recommended by Captain Maury).

Ship *Flying Dutchman*, Captain A. Hubbard, October 12, 1854, lat. 8° 55′ N., long. 40° 52′ W.—"I notice for the last two days (from lat. 11° 28′) the lines of agitated water, previously noticed, appear all to run nearly E.N.E. and W.S.W., and follow each other at regular intervals of some 4 or 5 miles; the motion of the waves running at right angles to the line of rip. October 14, lat. 6° 46′ N., long. 39° 4′ W., Current East, 1 knot. 15th, lat. 6° 50′ N., long. 37° 26′ W., Current East, 1½ knot. One year ago last July I experienced a similar Current in the same latitude, but some 10° farther East. October 16th, lat. 6° 49′ N., long. 36° 25′ W., East 1¼ knot. 17th, lat. 6° 29′ N., long. 35° 18′ W., S. 79° E. 2 knots. 18th, lat. 5° 59′ N., long. 34° 19′ W., East, Northerly, 1½ knot. 19th, lat. 5° 43′ N., long. 33° 33′ W., East, Southerly, 1½ knot, slight current rips. 20th, no Current. All these days generally calm, or light variable airs."

Ship *Raven*, Captain J. Crocker, October 27, 1855, lat. 6° 18′ N., long. 29° 50′ W., Current N.E. 1 mile. 28th, lat. 5° 24′ N., long. 29° 50′ W., N.E. 1 mile. 29th, lat. 5° 10′ N., long. 30° 0′ W., N.E. 1 mile. 30th, lat. 4° 40′ N., long. 30° 0′ W., N.E. 2 miles.

Ship *Robert Putten*, Captain G. S. Paine, October 30, 1856, lat. 10° 14′ N., long. 33° 50′ W., "tremendous tide-rips, the strongest I ever saw." October 31, lat. 8° 26′ N., long. 32° 38′ W., Current changes to Eastward, ½ knot per hour.

Ship *Scargo*, Captain N. Crowell, October 4, 1856, lat. 6° 53′ N., long. 25° 13′ W., Current 24 miles East. 5th, lat. 6° 25′ N., long. 24° 42′ W., 18 miles E. by S.

6th, lat. 5° 36′ N., long. 23° 59′ W., 18 miles E. by S. 7th, lat. 4° 48′ N., long. 23° 29′ W., 18 miles E. by S.

Schooner *Thomas A. Ward*, Captain J. D. Hoff, October 30, 1855, lat. 6° 5′ N., long. 27° 40′ W., the last twenty-four hours have been the most calm that I ever saw, not a breath from any quarter, and a terrible rolling sea. We drifted S.E. 35 miles.

Ship *Colorado*, Captain Ricker, November 1, 1855, lat. 5° 51′ N., long. 21° 54′ W., Current 20 miles S.E. 2nd, lat. 5° 22′ N., long. 20° 55′ W., 20 miles S.E.

Barque *Clara*, Captain E. Cook, December 9, 1854, lat. 6° 48′ N., long. 26° 56′ W., 1·3 knot per hour N. 35° E. 10th, lat. 6° 9′ N., long. 27° 57′ W., 1 knot N. 62° E. 11th, lat. 6° 10′ N., long. 26° 46′ W., 0·8 knot N. 37° E.

The foregoing are the principal notices of the Easterly Current as recorded in Captain Maury's Sailing Directions, vol. ii., 1859, and, in fact, is nearly all that is mentioned on Currents, as but very few, if any, of the abstract logs quoted in that work mentioned any Westerly or other Currents, the only exception being that in some very few cases a Northerly set is noticed. Besides this, there is frequent mention of current or tide-rips, often of a very formidable character, denoting great activity and change in the Currents of this troublesome region.

(276.) Some records of more recent Bottles are given below :—

A Bottle from the ship *Douro*, in long. 31° 5′ W., on the Equator, June 23rd, 1880, was picked up on the beach near the entrance of the River Niger, in lat. 4° 43′ N., long. 6° 35′ E., in April, 1881. The least distance traversed was about 2,300 miles, in 10 months. (See Drift diagram, page 297).

A Bottle from the ship *Patriarch*, in lat. 2° 46′ N., long. 22° 8′ W., December 11th, 1884, was picked up on the beach near Grand Popo, in May, 1885, having drifted about 1,200 miles in five months. (See Drift diagram).

Four Bottles from the steamer *Buccaneer* :—One, in lat. 6° 40′ N., long. 12° 32′ W., January 6th, 1886, was washed ashore, March 5th, 1886, 10 miles from Addah, in lat. 5° 47′ N., long. 0° 35′ E., having drifted 862 miles in 58 days, or 15 miles a day.

Another, in lat. 4° 49′ N., long. 9° 38′ W., January 8th, 1886, was found on the beach at New Sierra Leone, lat. 6° 8′ N., long. 1° 17′ E., March 2nd, 1886, having drifted 690 miles in 53 days, averaging 13 miles a day.

Another, in lat. 6° 25′ N., long. 14° 31′ W., March 14th, 1886, was washed ashore on the beach, in lat. 4° 45′ N., long. 8° 31′ W., May 12th, 1886, having drifted 372 miles in 59 days, at the rate of 6·3 miles a day. (See diagram).

Another, in lat. 0° 21′ N., long. 7° 36′ E., January 29th, 1886, was picked up on June 25th, 1886, in lat. 3° 14′ N., long. 9° 57′ E., having drifted 230 miles in 147 days, or only 1·6 mile a day. (See Drift diagram).

The first two were thrown overboard to the West of Cape Palmas, and were carried very rapidly to the Eastward. The third was also thrown over to the Westward of Cape Palmas, but much farther off shore, and in the month of March. It was drifted right across the routes of the first two, and was cast up on the Kroo coast. Had the same current prevailed in March as did in January, on arriving in the track of these it ought to have been carried, like them, into the Bight; instead of this, it never even passed Cape Palmas. The fourth was thrown over between the Gaboon River and St. Thomé, and drifted very slowly in a North-Easterly direction, and stranded near Cameroon River, having required 147 days to make good a distance of 230 miles. No doubt it covered a great deal more ground, being drifted backwards and forwards by the very conflicting currents of this region.

(277.) One of the most remarkable examples of this Easterly Current recorded, and one which unmistakably demonstrates its existence and activity, was encountered by John Alexander Mann, Esq., F.R.G.S. and F.R.A.S.* He left Cayenne in French Guayana, in the brigantine *Monte Christo*, 120 tons, bound for Paranahyba, on July 26th, 1862, the day of the new moon; the wind blowing from the East. A direct Northerly course was steered until the 30th, when the ship was in 7° N., and the log, by dead reckoning, was the same as Cayenne, *i.e.* 52° 14′. On August 7th, spoke the Austrian brig *Rarita*, which gave longitude 27° 14′; that of the dead reckoning of the *Monte Christo* gave 42° 14′, so that the vessel had been drifted *nine hundred miles* to the Eastward, and for eight consecutive days she had been drifted 3¾ knots an hour to the E.S.E. There was a great doubt as to the accuracy of the longitude, but at noon of the 15th, in lat. 0° 45′ S., they spoke a Dutch brig, which gave the longitude as 27° 8′, while the D.R. placed them in 44° 0′, which, compared with the position on the 7th, shows that they were drifted 120 miles farther to the Eastward. In fact, had the ship been left to the Current, it would have soon reached the African coast, having drifted 1,020 miles in 20 days.

Throughout the remainder of the voyage, which lasted 14 days longer, the same Current was experienced. The captain of the *Loyal*, which arrived some days after, abandoned his chronometer from the same cause, believing it to be out of order. Afterwards, in sailing from Surinam to Cayenne, in the *Alecton*, French man-of-war steamer, Mr. Mann met with the same phenomenon.

(278.) These facts are very important, in connection with the Westerly crossing of the Equator, which has been strenuously advocated, and the influence of this powerful Current, which appears to have much constancy during the Northern summer months, may have much to do with the readiness with which vessels, having reached too far to the Westward, contrive to weather the Eastern extremity of Brasil. This will be adverted to hereafter.

(279.) The Easterly Current thus passing across the Atlantic strikes the coast of Africa about Sierra Leone and the coast of Liberia. Of course, when near the shore, it assumes its direction to the S.E., and runs with great velocity. As is shown by the Chart of the Currents, at page 295, its mean annual velocity is between 14·1 miles and 26·5 miles per day, strongest in the summer months.

Its mean direction off Cape Palmas and Cape Coast Castle is E. 12° N., and its calculated velocity from Major Rennell's and Captain Maury's observations is—for January, 17·4 miles to 27·6 miles; February, 26 miles to 32 miles; April, 11·5 miles to 33·7 miles; May, 22·7 miles to 36 miles; June, 30 miles; July, 18·2 miles; August, 15·7 miles to 26·4 miles per day. These are from the records of 75 observations.

(280.) Its Southern edge appears to be in about 2½° to 2° N. up to the head of the Bight, and as the Southern streams set in an opposite direction, they are serviceable in making a return passage as presently explained.

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* See Proceedings of the Royal Geographical Society, Vol. VII., 1863, pages 50, 51.

The temperature of the Guinea Current is high, and demonstrates its Equatorial origin, although the branch of it which comes from the Northward past Cape Verde has probably a lower temperature as coming from a higher latitude. The Equatorial Current to the Southward of the Guinea Current is also of a lower temperature, coming direct along the African coast from the Southern Polar regions. The mean summer temperature is about 78°, but in our winter and autumn months it is higher, being from 82·6° to 83° as a mean, and sometimes it is found higher than this.

(281.) H.M.S. *Challenger*, in crossing this Current, August 10th to 21st, 1873, made the following observations on the Temperature of the sea at different depths. From the Cape Verde Islands, 300 miles West of Cape Verde, her track was in a general South-Easterly direction for 88 miles to a position 150 miles S.S.W. of Sierra Leone; thence, in the next two days, she proceeded to a position 160 miles to the S.S.W., or 310 miles from Sierra Leone.

Temperature Observations, in Degrees (Fahrenheit), by H.M.S. Challenger, while crossing the Guinea Current, in August, 1873.

DEPTH.	POSITION OF SHIP.									
	19° N. 24° W.	18° N. 24½° W.	13½° N. 22½° W.	12¾° N. 22¼° W.	10¼° N. 20¼° W.	9½° N. 18½° W.	8° N. 17½° W.	7° N. 16° W.	5¾° N. 14½° W.	3° N. 15° W.
At the Surface...	74	74	79	79	78	78	78	79	79	78
,, 25 fathoms	—	—	—	60	69	65½	—	—	72	—
,, 50 ,,	—	68	—	54	59	59	68	61	62½	65
,, 75 ,,	—	—	—	53	55	55	—	—	59	61
,, 100 ,,	57½	62	52	51	53	54	56	55	56	57
,, 200 ,,	54½	52	50	48½	48½	47	50	49½	53	51
,, 300 ,,	50	47	46	46	43	45	45	43	43	42
,, 400 ,,	46	43	42	42	42	41	41	41	40	40
,, 500 ,,	43	42	40	40	40	41	41	40	40	39
,, 1000 ,,	38	38	38	—	38	—	—	38	—	—
,, 1500 ,,	—	36	36	—	—	—	—	37	—	36

The above Table, it must be remembered, refers to the time of year when the Guinea Current is at its greatest power. Subsequently, in returning home, the *Challenger*, in the passage from Ascension to the Cape Verdes, in April, 1876, found the surface temperature in lat. 2° 30′ S. to be 82½°; in 0° 15′ S., 81½°. In lat. 3° N., long. 15° W., 300 miles S.W. of Cape Mesurado, the temperature was 83° on the surface, in the same position in which a temperature of 78° only was found in August, but the warm water did not penetrate to so great a depth. At 50 fathoms, 65° was found in August, but only 59° in April. Sir Wyville Thomson remarks:— "Where the rate of the current is highest, we have as usual a rapid fall in the temperature below the surface. This is caused by the cooler water rising to supply the place of the hot surface water, which is being rapidly drifted and evaporated away."

(282.) At the distance of about 177 miles South of Cape Palmas (long. 7¾° W.) the outer border of the Guinea Current sets to the East; and it continues in the same direction to a similar distance South of Cape Three Points (long. 2° W.); we thence, at 2° North of the Line, find it take a more Northerly course, toward the Bight of Benin and the Bight of Biafra; in the latter it mixes with the waters of the *South African Current*, which, coming from the South, sets thence to the North and N.W., and both, uniting, form a head in the bight. From this bight and Southward of the Equator the Currents thus blended set to the S.W., W.N.W., and N.W. in one expanding and united stream, which greatly facilitates the passage of ships from Fernando Po to Sierra Leone.

The prevalence of the Harmattan wind, described on pages 164—168, must interrupt the course of this Current; but its existence, at other times, nearly as described, has long been confirmed, and is incontestable.

(283.) Near Cape Mount the Current sets in towards the shore as above stated. The ship *Charles*, a French whaler, in 1833, was wrecked on the coast of Liberia, about 90 miles to the S.E. of Cape Mesurado, probably on the reefs near the River Sestros. This vessel had left the port of Havre for the fishery near *Tristan da Cunha*, in the Southern Ocean, but the captain, intending to run along the coast beyond Cape Palmas, in the hope of falling in with whales, unfortunately lost his reckoning, by being deprived, for forty-eight hours, of all means of taking observations; and was moving at the estimated rate of 7 miles an hour, when he found himself close on shore in the midst of breakers, which in the course of the night forced him on the reef, and dashed the ship to pieces. The captain and crew got safe to land, but were soon stripped by the blacks. In this condition they made their way along the shore to the N.W., until they reached Cape Mesurado, where they were received with all kindness by the colonial agent of Liberia. The catastrophe is evidently attributable to this Easterly Current.

Captain C. T. Rudge, ship *Jane Black*, December, 1856, says:—"It is my opinion that the current along the coast from the Bissagos Shoals to Cape Palmas is variable; and in the parallel of Cape Mount, coming from the Westward with S.W. winds, I have always found northing in the set, let the current be Easterly or Westerly. Ten miles off the land the current runs parallel to the land either way, strongest off the capes. I have commanded ships on the West coast of Africa 12 years, and have found the currents very variable at all times."

On the Western side of Cape Palmas it sets along shore with such force to the S.E., that ships which do not steer a point nearer than the true course will be carried from the land. About *Cape Three Points*, likewise, the stream runs strongly to the Eastward, and frequently sets directly in upon the reefs about that cape. Eastward of this cape the Current has carried many experienced mariners, bound to Cape Coast or Annamaboe, to leeward of those ports, and occasioned much trouble, with delay, in beating up again. About *Terra Formosa*, in July and August, the Current has also been found to set strongly to the Eastward.*

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* In the *Derrotero de las Antillas* the following remarks are said to have been found

(284.) Enseigne C. Martin states that from the experiences of French cruisers on the West coast of Africa, it is found that between the Canaries and Cape Palmas the current is very weak and close to the coast, being rarely felt Westward of long. 16°. From Cape Palmas to Cape Formosa it follows the trend of the coast, and appears to divide against the latter cape, a weak portion continuing its course between the Niger and Fernando Po, the main body appearing to trend off to the South and S.W. In the channel separating Fernando Po, Princes, and St. Thomas Islands from the coast, the current was generally found running N.W., perhaps due to the outflow of the River Congo. Here this seems to meet the S.W. branch of the Guinea Current, and the two combining bear off to the Westward as the Equatorial Current.*

(285.) Mr. J. Y. Buchanan, F.R.S., gave a paper at the British Association, 1892, "On the Temperature, Density, and Motion of the Waters of the Gulf of Guinea," from observations made in the telegraph steamer *Buccaneer*, in January, February, July, August, and September, 1886. He states that the surface-water of high temperature all over the Gulf of Guinea forms a layer of generally not over 30 fathoms in thickness. A moderate breeze off shore easily blows it away, and its place is taken by the denser and colder water immediately below it. Generally, the current along the Guinea coast was found to set strongly to the Eastward, as the well-known Guinea Current, and this was confirmed by the current bottles thrown overboard and afterwards found. In the Bight, near the Island of St. Thomé, the current set in a North-Westerly direction and was strong enough to set the ship back, while heaving in the sounding wire, by about as much as she steamed forward between soundings.

Between Ascension and Conakry, some interesting current observations were made in the neighbourhood of the Equator. Here a strong current to the Eastward was found at 50 fathoms, as much as 1·3 knot per hour, the surface-water setting to the Westward at about 0·5 knot per hour; so that the net Easterly current below was at least 0·8 knot per hour.

The change in the character of the Current at different times is shown by the fact that from the Equator towards Sierra Leone, in March, the *Buccaneer* experienced no Easterly current, and a bottle thrown overboard was washed ashore on the Kroo Coast, whereas, if the same current had prevailed in both March and January, the bottle would have been carried round Cape Palmas and into the Gulf of Guinea.

(286.) Thus far, we give a general description of this remarkable Current. What follows is from the Meteorological Office Monthly Analysis, 1872, with which is incorporated further information gained from a study of Captain Toynbee's work on the Meteorology of the Area included between

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among the papers of the deceased Admiral Don Josef Varela. "At Prince's Island, and in its vicinity, the waters generally run to the *North*, which circumstance ought to be kept in mind in making the island, and steering for the anchorage. There are also currents to the *South*, but they are not so strong, nor of so long duration. The pilots of the place say that the currents depend on the phases of the moon, but we found that they were irregular." From this we may infer that there is some irregularity in the outset or revolving current; for which, consequently, every precaution should be taken.

* "Revue Maritime et Coloniale," tome 65, 1880, pp. 5—22.

lat. 20° N. and 10° S., and long. 10° to 40° W., published by the Meteorological Office, in 1876. (See the Diagrams illustrating the Best Monthly Routes Across the Equator).

The observations made on the Western portion of the Guinea Current are neither as complete nor as numerous as might be wished, nevertheless they lead to the conclusion that from the 20th meridian Westward this Current undergoes periodical changes. We shall make this evident from a tabular statement of the information yielded by the charts illustrating the above-mentioned works.

GUINEA CURRENT.

Chart.	Commences in—		On 20th meridian flows between latitudes—
General	50° W.	8° N.	3° and 10° N.
January	25	6	2 ,, 10
February	26	10	*4 ,, 12
March	28	13	4 ,, 12
April	25	6	2 ,, 12
May	35	2	3 ,, 10
June	30	6	3 ,, 8
July	42	6	4 ,, 12
August	45	7	4 ,, 15
September	37?	8	3 ,, 14
October	50?	7	3 ,, 10
November	30	6	3 ,, 10
December	23	5	*3 ,, 10

It thus appears that the Guinea Current has its maximum extent in August, reaching to 45° W., and occupying 11° on the meridian of 20° W.; and having its minimum extent in December, attaining long. 23° W., and having a width of only 7° on the meridian of 20° W. From December to August it is extending its longitude Westward, and widening Northward; and from August to February it is losing its extension Westward, and its Northern limit is retreating Southward again.

(287.) In *January* the Guinea Current appears to originate about long. 25° W., lat. 6° N.; at long. 20° W. it extends from lat. 2° to 10° N. Here it is joined by the North African Current, which checks its tendency to the Northward, and the united waters flow Eastward along the coast of Guinea, being traceable nearly to Fernando Po. From its origin to Cape Palmas its rate is from 10 to 15 miles per day, but off this cape it acquires a greater velocity, ranging from 13 to 35 miles per day, which it maintains until it reaches the meridian of 5° E. The Southern limit of this Current is probably about lat. 2° N., but observations are here wanting.

In *February* it commences in long. 25° W., lat. 10° N., but is seldom felt so far West. From the 20th meridian it is well defined up to Fernando Po, trending Southward to St. Thomas, its Southern limit being about lat. 2° N. From 20° to 10° W. it has a rate of about 10 to 20 miles in the 24 hours, and seems to be occasionally reversed; from 7° to 0° W., its rate has been observed to be as much as 44 miles, though this can hardly be usual; farther Eastward the rate varies from 13 to 24 miles. An eddy current is indicated in the Bight of Benin.

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* During February and December, frequent *Westerly* Currents have also been reported here.

In *March* the Guinea Current can be traced from lat. 13° N., long. 28° W. At first it appears as a weak current having a rate of 5 to 10 miles in the 24 hours; but near the African coast, and in about the region of 2° N. and 18° W., its velocity increases to 20, 30, and 40 miles, the strongest current being marked on its Southern limit.

In *April* it commences in about 6° N., 25° W., and rapidly widens till it extends from 8° N. to 2° N. on the 20th meridian, with a rate of 12 to 23 miles. It maintains about the same rate to long. 8° W. Between 5° and 0° W. its rate is from 26 to 36 miles; farther Eastward it loses strength, and either dies out in the vicinity of Fernando Po, or is deflected Southward, and drawn in with the Equatorial Current. The Current has been observed to run strongly to the Southward, in lat. 12° N., 28° W.

In *May* it seems to be felt at times as far West as 35° W., about lat. 2° to 5° N. In 30° W. it is farther North, and on the 20th meridian it lies between lat. 3° and 10° N. Along this route its rate is from 13 to 33 miles. As it nears the African coast, it is felt at times as a Northerly Current, probably influenced by the wind. Here, too, its rate is from 12 to 13 miles. In the Gulf of Guinea it is Easterly, the rates varying from 16 to 45 miles.

In *June* the Guinea Current probably commences about lat. 6° N., long. 30° W. Thence it spreads Northward and Southward, so that when it crosses the 20th meridian its width is from lat. 3° to 8° N. Its rate thus far is from 15 to 20 miles. Between 20° and 25° W. the North African Current is running strongly to the Southward between lat. 8° and 18° N. The Southern portion of the Guinea Current finds its way, but with considerable northing, into the Gulf of Guinea. Here its rate is strong, from 16 to 36 miles, and it appears to be confined within narrow limits of latitude. A counter-current has been observed in the Bight of Biafra. Captain Toynbee remarks:—"The Easterly Current on the coast of Africa has become stronger since May. Perhaps this may be accounted for by the fact that the N.E. Trade extends much farther North than in the winter, drawing more water *off* Africa, whilst there are fewer Westerly gales in the North to heap water against Africa, hence the deficiency must be made up by an increased Easterly current near to the Equator. It will be seen that it does increase in amount, and becomes more North-Easterly near the coast of Africa as the summer advances."

In *July* it is indicated about 6° N. and 42° W., if the observations here are trustworthy. Observations are wanting to the Eastward till it crosses the 35th meridian, between lat. 7° and 11° N. In long. 20° W. it extends from 4° to 12° N., its rate being from 15 to 20 miles a day. A portion of its waters is turned to the N.W. by the coast about lat. 10° N., and passes to the Northward past Cape Verde, but the main current passes into the Gulf of Guinea, attaining a rate of 28 miles. Between the meridians of 10° W. and 0° there are no observations of this Current, but it is shown Eastward, between the coast and lat. 2° N., where its rate is from 32 to 11 miles. Although the Western limit of this Current is not well defined, the data show that its rate and extent are remarkable.

In *August* the Guinea Current is indicated between lat. 8° and 10° N., in long. 45° W., and from 40° to 30° W. there are but few observations. It appears, however, to be running at a velocity of from 15 to 20 miles a day in this region to the Southward and Northward of East. At 30° W. it extends from 5° to 12° N. latitude, and at 20° W. from lat. 4° to 15° N. At this part its rate is between 10 and 25 miles per day. Farther Eastward it is stronger, and off Sierra Leone has a velocity of 50 miles, with direction Northward of East. Abreast Cape Verde it neutralizes the North African Current.

In *September* it can be traced to 37° W. longitude. In long. 30° W. it extends from 5° to 10° N. latitude; in 20° W., from 3° to 14° N., and its rate is from 8 to 32 miles. It maintains about the same rate in the Gulf of Guinea, where its Southern limit is about lat. 1° or 2° N. Its velocity is increased to 30 and 40 miles in the 24 hours in rounding the Coast of Liberia. It appears to neutralize the North African Current in about lat. 12° N., Southward of Cape Verde.

In *October* it has been noticed in 50° W., between 5° and 10° N. Thence to 30° W. there are only a few observations. At 30° W. it extends from 6° to 10° N., and at 20° W. from 3° to 10° N. Both the rate and set are variable, though the general tendency towards Africa is evident. Between 15° and 20° W., and 4° and 8° N., it appears as a strong Current, with a velocity of 30 to 40 miles in the 24 hours. In the Gulf of Guinea its rate is greater than in 20° W., but nowhere exceeds 23 miles. The isotherm of 80°, in lat. 3° N., seems to mark the border of this Current.

In *November* it cannot be traced farther than 32° W. At 30° W. it extends from about 4° to 10° N., and at 20° W. from 3° to 10° N. It appears to be now losing strength and regularity. From 20° to 10° W. the observations are deficient in number. Off the Coast of Africa it runs more to the Southward of East than in previous months, indicating the effect of the Westerly winds North of the N.E. Trade, driving water against Africa, which runs to the Southward. In the Gulf of Guinea it is also feeble and unsettled as to direction.

In *December* the Guinea Current is indicated in 23° W., latitude 4° to 6° N. The set is irregular, and the rate feeble, from 11 to 14 miles. It has contracted in breadth since November. At longitude 18° W., its breadth is probably from 3° to 10° N. latitude. Thence to longitude 10° W. observations are wanted. The Current has been observed far to the Westward in this month, in one or two instances between lat. 6° and 8° N., and long. 35° and 40° W., and also in 47° W. and 5° N. In the Gulf of Guinea it flows between the coast and lat. 2½° N., at a rate varying from 20 to 36 miles.

4.—THE SARGASSO SEA.

(288.) The central portion of the North Atlantic Ocean, which is comprised between the Trade Wind and Anti-Trade Wind systems (42), page 124, also bounded on the South by the Westerly Drifts of the Trade Winds, and to the North by the Easterly Current, presently described, appears to be in a different physical condition to the other portions of the Atlantic Ocean, and indeed from any other portion of the globe.

Its apparently chief characteristic is well expressed by the name now usually applied to it—the *Sargasso*, or *Weedy Sea.* The well-known *gulf-weed,* which is found more or less over its whole area, seems to be quite peculiar to it. There may be a somewhat analogous physical condition in the North Pacific Ocean, but this is not so easily defined. This gulf-weed is constantly found, in greater or less quantity, scattered over its whole area, and when it is found in places not its usual habitat, it may be safely inferred that it has drifted out of this extensive area by the action of the Current.

(289.) It is very difficult to define the limits within which this gulf-weed is found. The fluctuations of the seasons greatly affect them, as they do the limits of the Trade Winds and intervening Calms, the more particularly as it is to the varying Currents caused by these winds that the weed is retained in its locality. Consequently, we may look for its North and South boundaries more to the Southward during the Northern winter months, and the reverse during the summer. The Tropic, or about the parallel of 23° N., may be its Southern edge in the longitude of the Azores, from whence this limit extends to the Virgin Islands and the Bahamas. Its Northern edge runs from the Azores to the outer edge of the Gulf Stream off Cape Hatteras. This will give a breadth of 1,000 miles in its Eastern part, and a length of 3,000 miles from East to West. As before stated, its limits may change greatly at different times, but it may always be looked for within this area, that is between the Southern edge of the Gulf Stream and the Northern limit of the Equatorial Current.

According to the investigations of Dr. O. Krümmel,* the area of maximum weediness (where the weed covers from 10 to 25 per cent. of the surface) forms an ellipse between lat. 25° and 35° N., and long. 40° to 73° W. The weed has been found as far North as lat. 52°, in long. 45° W., and as far South as 15° N., but it is only found Northward of lat. 45° N. in late summer and autumn.

(290.) There has been much speculation as to the causes and conditions which have made and retained this peculiar area in its integrity.

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* A good account of this weedy sea, which is called by the French "Mer de Varec'h," by Captain Leps, of the French Navy, is given in the "Annales Hydrographiques," 1857, page 565, &c.; another more recent account, illustrated by a map, is given by Dr. O. Krümmel, in Petermann's "Mitteilungen," 1891, pp. 129—141. As the conclusions there arrived at entirely accord with the particulars given in this volume, it has not been thought necessary to quote from them to any large extent.

Major Rennell says:—It has been observed that the waters of the Atlantic have a greater tendency toward the middle of the Ocean than otherwise, and this seems to indicate a reduced level, forming a kind of hollow space or depressed surface. It is certain that the setting of the Currents is such as might be expected to take place if such a hollow existed; for the Currents do really set into the Sargasso Sea from the North and from the South; whilst in the middle part, although within the region of the Trade Wind, the Currents are not regular, but indicate a kind of vortex.*

By others it is considered as an immense eddy or whirlpool, formed by the inclination of the water to the Westward, caused by the influence of the Trade Winds and the Gulf Stream.

Others, again, argue that it is a raised surface, maintained in a quiescent condition by the surrounding currents, and retaining all floating matter that is poured into it by the surrounding influences.

It is also considered as the grand receptacle of the Gulf Stream, which, recurving at the Azores, here turns into this space all that it has transported through its long course.

All these theories have some facts to bear them up in some degree, but others can be adduced to show their futility.

(291.) It is here urged that a simple explanation can be given of this curious region, in the analogous condition of the atmosphere, so powerful an agent in the production or alteration of Ocean Drifts and Currents.

By referring to Maury's Trade Wind Charts, cited on page 128 (48), it will be seen that there is an uncertainty about meeting with the Northern edge of the N.E. Trade Winds through an extent of at least 10° of latitude; add to this the vibration of this zone of Trade Winds consequent on the motion of the sun in the Ecliptic, which amounts to from 5° to 8° in latitude, as exemplified in the diagram of the limits of the Trade Winds at page 125, and we have a range of 15° to 18° of latitude over which, during some portion of the year, and over a large section of it throughout the year, there is nothing but light airs and variable winds, being, in fact, the "Horse Latitudes," *see* page 168 (96 to 100).

Under this zone, therefore, the sea is subject to no continued or regular drift, and, consequently, whatever is thrown on to its surface will remain for a long time, and the Sargasso, or gulf-weed, being one of the few marine plants which lives when broken from its rocky bed, may exist here for a very long period, and thus accumulate by the fresh additions constantly brought by the outer or Eastern edge of the Gulf Stream, as well as that drifted around the Northern part of the Atlantic, and passing with the S.E. current by the Azores (262) into this quiescent zone. That the Gulf Stream is the primary feeder to this weedy sea will be shown presently.

(292.) There is another condition, also, which favours the maintenance and growth of this peculiar plant. The temperature of this water is very equable, less warm than that under the more vertical sun, and not varying more than 6° or 7° Fahr. throughout the year in the Eastern part, or 8° or 9° in the Western part. This temperature is, as said, lower than that of the Southern part of the great Equatorial streams to the South of it, but it is higher than that of the Current which sets S.E. and South between the Azores and Spain, and lower than that of the surface of the Gulf of Mexico and the early course of the Gulf Stream. It may, therefore, be considered that it approximates to the water-climate of the bottom near the shores of the Gulf of Mexico, that of the sea around the Bahamas, &c., where it is known that this weed grows naturally.

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* Rennell's "Investigation," page 72.

(293.) The *Sargasso* or *Gulf-weed*, which is the peculiar characteristic of this area, is one of the few plants, aquatic or terrestrial, which will live and flourish when separated from its native stem. Its appearance is too well known to require any detail. The sea was called *Sargaçao* by the early Portuguese navigators, from the weed bearing berries like grapes, "sarga." This term has thus been corrupted into *Sargasso*, and been applied to the plant itself instead of the place it grows on. There are more than one species of it known to botanists, as *sargassum vulgare*, &c., distinguished from each other by the form of the leaves and the fructification. These different species are more or less abundant in different localities. It is frequently called *fucus natans*—floating sea-weed; and is known to sailors as *gulf-weed*, that famous stream being always more or less marked with it.

(294.) The old story of Columbus, who had much difficulty with his men, when they declared that even the sea changed its nature into terrestrial to prevent his proceeding on his discovery voyage to America, has been oft repeated. In his account he stated that "sometimes the weed comes in such compact masses as to cause the sea to look like a coagulated mass."

The sea is commonly studded over, like an inundated meadow, with the bushes, which are in some places very abundant, and in others more dispersed. If we imagine the surface of a wide extended moor, covered with water, the furze and heath bushes would appear something like the clusters of fucus scattered over the thickest part of this sea.

The fructification of all sea-weeds is peculiar, but they require a fixed basis to vegetate. Although apparently flourishing in vast areas in the Sargasso Sea, they can only be looked on as cut flowers rather than as complete plants, although their constitution enables them to live a long period without being fixed to their parent rock like most other algæ. They are found in every state of decay, and when old they become covered with minute and beautiful parasitic growths, which deserve much attention by those who have the leisure and taste to examine them, especially with the microscope, which in this region reveals a vast and little known world. Besides this, too, the tufts afford protection and shelter to a vast quantity and variety of minute fishes, crabs, and other crustacea and animalculæ, which will afford an inexhaustible fund of interest to the observer. Naturally enough, there is a limit to its separate existence, and when subjected to any change of temperature, or difference of locality unsuitable, by a continuous wind or current, large areas become decayed, die, and sink to the bottom, to be renewed by the continual fresh importations from the Gulf of Mexico.

It is sometimes drifted on to the shores of the British Isles and Western

Europe, and appears among the other sea-weeds in the various works on algology, but it is accepted as a shipwrecked stranger, not as a native of our shores.

(295.) The Gulf of Mexico abounds with the native growths of the Sargasso weed. It is found attached to the rocks, at the bottom, in most parts of it. The soundings on the Campeche Bank, Chiriqui, the Andros Islands, on the Bahama Banks, New Providence, &c., all furnish the supply of growing plants. The spores (or seeds) of these become attached to these rocks in the manner usual with all *algæ*, and the young plant grows, not from a root, because the attachment to the rock is not of that nature, till it attains some size, when offering greater resistance to the progress of the continual current than the stalk is able to bear, it becomes detached, rises to the surface, and then is borne onward by the stream till it emerges through the Gulf of Florida by the Gulf Stream. As will be shown hereafter, this stream has a tendency to throw all floating bodies off to the right-hand of its course; it follows, that this weed is gradually cast off into this central area, aided probably by the Westerly prevalence of the winds which at times occur in this part.

One opinion may be safely controverted, that which assigns the depths of the Atlantic over which it is found as its native place. The great depth and consequent cold disproving the possibility of a plant living in such extremes of temperature.

In the Paper mentioned in the note on page 335, Dr. Krümmel calculates that after leaving Florida Strait or its vicinity, it would take about six months for this weed to reach a position West of the Azores. It then moves away very slowly, and gradually decays and sinks.

(296.) H.M.S. *Challenger*, in crossing the Sargasso Sea (June 14th to July 1st, 1873), found the Current variable, both in strength and direction; in 63° W. 19 miles N.E.; in 59° W. 12 m. N.E.; in 53° W. 6 m. S.S.E.; in 50½° W. 17 m. E. by N.; in 49° W. 18 m. N.N.E.; in 45° W. 6 m. West; in 42° W. 22 m. N.W.; in 38° W. 27 m. North; in 36° W. 4 m. North; in 35° W. 16 m. E.S.E., and in 32° W. 8 m., S.W. The depth westward of 38° W. was between 2,000 and 3,000 fathoms, with a bottom of oaze, and with no signs of weed, disproving entirely the idea of some naturalists that the weed grows in this locality. Eastward of 38° W., the depth varied from 1,675 to 1,000 fathoms. The temperatures of the sea surface were greater in the Western part of the district, 73½°, than in the Eastern, where it was generally found to be about 71°; at 100 fathoms the temperature was about 66°; at 500 fathoms about 48½°; and at 1,000 fathoms about 37½° Fahrenheit.

"The floating islands of the gulf-weed, with which we had become very familiar, as we had now nearly made the circuit of the 'Sargasso Sea,' are usually from a couple of feet to two or three yards in diameter, sometimes much larger; we have seen, on one or two occasions, fields several acres in extent, and such expanses are probably more frequent nearer the centre of its area of distribution. The general effect of a number of such fields and patches of weed, in abrupt and yet harmonious contrast with the lanes of intense indigo which separate them, is very pleasing. These floating islands have inhabitants peculiar to them, and I know of no more perfect example of protective resemblance than that which is shown in the gulf-weed fauna."—*Sir Wyville Thomson*, "Voyage of the *Challenger*," vol. ii., pp. 9—10.

(297.) Captain Andrew Livingston, on his way from New Orleans to the Strait of Florida, saw large quantities of it; and every one who has navigated the Gulf Stream has remarked the weed in it, or along its borders. Sir Philip Broke and the Baron Alexander von Humboldt say that the stream contains a great deal. Sir Philip says, "We were always surrounded with gulf-weed." Major Rennell adds, "He spoke of that part of the Gulf Stream out in the Atlantic; the others might speak of other parts."

In the "Sailing Directory for the Windward and Gulf Passages, the Bahama Islands, &c.," by A. G. Findlay, is a description of Andros Island, and it is there shown, that in the great sponging district, upon the Bahama Bank, West of Andros, vast quantities of the gulf-weed are produced; and this is one of the beds from which the ocean has been supplied.

On this subject, we have the following remarks by Captain Livingston, whose name has so frequently occurred in the preceding pages:—

"Many persons suppose that the gulf-weed *(fucus natans)* grows upon the rocks about the Bermudas; others, that it originates among the Florida Reefs; and a third party, that it grows upon the water, without ever adhering to anything fixed.

"All these positions seem to me equally wide of truth. Neither on the Bermuda Rocks, nor among the Florida Reefs, has a single branch of gulf-weed ever been found growing upon the rocks; and, among all the gulf-weed met on the ocean, no person has ever found a single tuft with roots, or that, on mature examination, could be supposed, by any person of sound judgment, to have grown on the surface of the water. On the contrary, every stalk of the weed seems to have been broken off short from something to which it firmly grew, and *all the ends* of these stalks are uniformly decayed, or dried up, from the end to a short distance.

"It has been stated, as a well-known fact, that the *fucus natans* grows on the rocks along the Gulf of Paria, and on the coasts of Caraccas, &c. If this be the case, it is rather strange that it should not rather grow on other rocks and coasts of the West Indies. It has also been stated, that in the whole sea of floating bushes, *Mar do Sargasso*, not a withered plant is ever discovered. This is not true, as I have seen abundance of *fucus natans* in a state of great decay. I note the following from my journal of the *Brilliant*, from Gibraltar towards Havanna: February 8th, 1819, 'the weed much decayed;' 9th, a.m., 'weed passed through, much decayed;' 10th, p.m., 'passed through much decayed weed; I remark, that the farther we run to the Westward, the more decayed is the gulf-weed;' 13th, 'the gulf-weed begins to look fresher.'*

"These particulars have been given in order to show that I have not spoken at random; on the contrary, actually made my remarks on the spot.

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* On the 8th of February, the *Brilliant* was in 24° 17′ N. and 65° 1′ W. On the 9th, in 24° 34′ N. and 66° 59′ W. On the 10th, in 24° 51′ N. and 68° 39′ W. On the 12th, in 25° 34′ N. and 71° 5′ W. On the 9th, the ship passed the meridian of Porto Rico, and was hence proceeding toward Providence Channel, Bahama. The decayed weed, we have no doubt, had drifted from the central area of the ocean.—Ed.

Some of the weed was quite brown, and in small fragments, evidently separated into such by its state of decay. It is true that the weed soon decays when it is taken out of the water, as I have often tried the experiment. The weed is never of a verdant green colour, but seems as if blanched from having been, in some degree, hid from light; I suppose from vegetating under water."

(298.) Mr. Turner, and many other botanists, thought that the greater part of the *fuci* (weeds) which we gather on the surface of the ocean, and which, from the 23rd to the 35th degree of latitude, appear to the mariner like a vast inundated meadow, grow primitively at the bottom of the ocean, and float only in their ripened state, when they are torn off by the motion of the waves.

" The causes that uproot these weeds, at depths where it is generally thought the sea is but slightly agitated, are not sufficiently known. It has been said, that if the fucus adheres to the rocks with the greatest firmness before the display of its fructification, it separates with great facility after this period, or during the season which suspends its vegetation, like that of the terrestrial plants. The fish and the molluscæ that gnaw the stems of the sea-weeds no doubt contribute also to detach them from their roots.

" On proceeding hence, toward the West Indies, from the 22nd degree of latitude, we found the surface of the sea covered with flying-fish, which threw themselves up into the air 12, 15, or 18 feet high, and fell down on the deck. I do not hesitate to speak of an object, of which voyagers discourse as frequently as of dolphins, sharks, sea-sickness, and the phosphorescence of the ocean. None of these objects can fail of affording interesting observations to those who make them their study."

(299.) Captain Bourke, in the brig *Archibald*, December, 1815, found large quantities of the weed near the parallel of 20°, to the Northward of the Island Porto Rico, and of the Eastern part of Hayti; but on the passage through the Bahama Channel, Eastward of the meridian of 70°, and on the North sides of Hayti and Cuba, none of the weed was seen. This may be accounted for on the supposition that it was drifted by the current from the great bed of weed to the N.E., as before explained.

Lieutenant John Evans, R.N., states:—"In November, 1810, H.M.S. *Belvedere*, in the centre of the Atlantic, lat. 33° 20′, long. 41° 37′, passed through prodigious quantities of *fucus natans*, in line North and South, as far as the eye could see; and, notwithstanding that there prevailed a very heavy swell from the North, their position was not altered. The quantity of this weed met with between the 30th and 36th degrees of latitude is really astonishing; at times you may sail for leagues through it, covering, as a mantle, the surface of the sea. I have often seen it in lines about 300 or 400 fathoms in length (sometimes only a few yards), and frequently in large and small patches of irregular shape, but generally in a circular form. The deep-sea line should be put over the side frequently in this particular part of the Atlantic."

On the 17th of April, 1828, at noon, in the Mexican Sea, a vessel, under the command of Lieutenant John Evans, was in lat. 26° 52′, long. 89° 17′. On this day *fucus natans*, or gulf-weed, was seen, in parallel lines, S.S.E. and N.N.W. It was in flower, and completely covered with young barnacles. "From lat. 25° to 28° in this sea we met with fucus in parallel lines, S.S.E. and N.N.W.; it flowers like fern and other *cryptogamia*. In calms, the fuci float near the surface, some of the leaves appearing above water; the patches seen in the Florida Stream, and the bunches examined, were old, brown, and covered with young barnacles."

In the year 1825, the brig *Erin*, from the Pacific Ocean to Liverpool, when to the Westward of the Azores, passed compact parallels of *fucus natans*, in lat. 39° 59′, long. 33° 46′. The weed was less broken than any they had before seen; the nodules large and of a deep yellow-brown colour, and the lines extending, as far as the eye could reach, in a direction about S. by E., being nearly at right angles with the vessel's line, which was E. by N. The wind was S.E. by S., strong gales and a heavy sea.

(300.) The *fucus natans* is found in localities to the Eastward of the Sargasso Sea. For the following communication we are indebted to the late Captain Thomas Midgley, and it is a great acquisition to our knowledge of the wide range that this plant has :—

"On my outward passage to Africa, in a perfect calm, at daylight on the morning of the 18th of January, 1841, in lat. 6° 46′ N., long. 14° 56′ W., I found the ship amongst a number of small bunches of weed, and many cuttle-fish shells.

"On carefully examining some of the bunches of weed, I was surprised to find it the true *fucus natans*, or Sargasso or gulf-weed, being in every respect precisely the same as that found in the N.E. Trades, but apparently much fresher, having exactly the same kind of oblong, narrow, serrated leaf, same stem, same nodules, and just the same pale yellow colour. The pods were also surrounded with a very fine kind of network *(flustra)*, and there were a very few minute barnacles attached to the stem, which scarcely showed any marks of decay; indeed, the two bunches brought on board (which were each about 4 inches in diameter) appeared to have been but very recently separated from the parent stem, and they each contained a small but very lively crab.

"The lively fresh appearance of the weed, and the two crabs, induced me to try for soundings, and, as the weather was perfectly calm and the water smooth, I was enabled to get a perpendicular cast of 112 fathoms, with a well-armed heavy lead, but found no bottom.

"The weed was in detached and small bunches, and could only have tended over a comparative limited space; for when a breeze of wind sprang up, and the vessel had sailed 20 miles to the Eastward, there was not a single sprig or bunch to be seen.

"This weed appears to be unknown upon the Kroo coast, for I had two intelligent natives of Sangwin and Grand Sestros on board at the time I picked the weed up, and they severally declared they had never seen it upon any part of the coast.

"The vessel had been perfectly becalmed for fourteen hours previous and two hours subsequent to the time of picking up the weed, so that she gradually drifted amongst it by a current, which I found, by good observations and carefully-kept reckoning, to set E. by S. by compass, very nearly three-quarters of a mile per hour. Temperature of water, when weed was picked up at daylight, 79°, and at noon, 81° F."

(It had evidently been drifted out of the area by the Guinea Current, described on pages 325—334. Its not being known farther East is probably owing to the difference in the temperature of the sea, which kills the weed before it can arrive there).

(301.) Mr. Luccock, in his "Notes on Brasil," likewise described the *Green* or *Weedy Sea*. He states that it extends from 11° to 35° of North latitude, and from 30° of longitude to an indefinite distance Westward. "Here," he says, "the ocean is covered by nodules of sea-weed, from 3 to 18 inches in diameter, somewhat resembling in form a cauliflower when stripped of its leaves. They float lightly on the water, in parallel lines, at a very few yards from each other, and have a yellow-brown colour, like the long stringy fibre which is sometimes seen floating in the English Channel, and which I suppose to be the natural colour of all marine plants, growing deeply beneath the surface of the water. These nodules, or spherules, are composed of a vast number of small branches, about half an inch long, which shoot from each other at an angle of about 40°; hence they multiply continually towards the superficies of the sphere; and each extreme point produces a round seed-vessel. This is little more than one-tenth part of an inch in diameter, is hollow, and contains a small reddish-brown seed, scarcely occupying one-fifth part of the husk. The leaf of the plant springs from the joints of the branches, is oblong, indented at the edges, about 1½ inch long, and a quarter of an inch broad.

"When the nodule is dexterously taken up, all the branches may be traced to one principal stalk; and this invariably shows a fracture, the part by which it has been joined to some larger stem. This fracture is frequently quite fresh, and, in large and vigorous plants, shows distinctly a woody part and a cortex. On the edges of the latter, the first symptoms of decay appear. They become brown, and separate themselves from the wood. This, also, then assumes a darker colour, and exhibits the regular process of disorganization, just in the same manner as does a slip from a currant or gooseberry bush. In process of time, the whole of the plant assumes a darker hue; and, as it decays, floats considerably lower than it did. When kept out of the water for a few hours, it becomes harsh and brown, and acquires the peculiar smell of marine vegetables in a state of putrefaction.

"A great number of very minute barnacles are found upon the leaves and stalks. The seed-pod is usually enveloped in a sort of honeycomb work, which may be taken from it, and, when examined by a lens, resembles in appearance the network of a fly's eye. (This is called *flustra*). Among other inhabitants of the plant is frequently a number of small crabs, perfectly formed, and evidently young, yet vigorous and active; and when a nodule, taken fresh from the water at night, is hung up in a small cabin, it emits phosphorescent light enough to render objects visible.

"The singular arrangement of the plants, in parallel lines, is evidently owing to the wind, whose direction they always observe. Each nodule places itself under the lee of its more windward neighbour, and thus observes the law of floating bodies when exposed to a current of air. Should the wind suddenly change, as it sometimes does, a point or two, in this part of the Atlantic, and blow strong, these lines become broken, and form what are commonly called *fields of weed.* These, however, are generally small, and seldom, I suspect, remain long so disarranged."

Mr. Luccock was of opinion that the weed grew on the bottom in the area where it is found floating, but more recent explorations have disproved this, as before stated.

5.—THE NORTH EQUATORIAL CURRENT.

(302.) The name which is usually given to the great Drifts of the Trade Winds, having as wide a range of latitude as 50° or 60°, is scarcely expressive. The *Equatorial* Current, strictly speaking, is the counter-current we have just described. However, the Drift which is intended passes to the S.W. and West of the Azores and Canaries, and from the Coast of Africa to the Gulf of Mexico, Northward of the Easterly Counter-Current in the North Atlantic; while the great Drift of the S.E. Trade Wind, crossing the Equator Southward of the Counter-Current, and running strongly to the N.N.W., along the coast of Guayana, joins its strength to the Northern portion, and thus, together, they pass between the islands and through the Caribbean Sea.

The Drift of the N.E. Trade is not so powerful as that of the S.E. Trade, as the interference of the land causes such a great change in the regularity of the winds which certainly must be taken as the greatest cause in the production of these currents. In general, it is a very feeble current, and the mean rate has been over-estimated in former times by many observers. In its Northern limits in the open ocean its annual average, from a careful calculation, amounts from 8·2 miles to 11·6 miles per day; in its Southern and stronger portion it is from 16 to 22·4 miles per day. Westward of the Cape Verde Islands, its mean direction is nearly due West, which is remarkable, considering the northing of the Trade Wind. It would seem scarcely necessary to enlarge much upon the rate and extent of this well-known current; but, as it may be interesting to compare individual experience with that of preceding voyages, we give as heretofore a series of examples by which the ordinary rate and circumstances may be reckoned on.

(303.) H.M.S. *Challenger* (February 15th—March 14th, 1873), in crossing the North Atlantic directly between the Canary Islands and Sombrero, the Northern extreme of the Caribbee Islands, found the Current to flow as indicated in the Current Chart, page 295; the velocities, however, were greater in places. In long. 19° W. the Current flowed to the S. by W. at a rate of 10 miles in the 24 hours; in 22° W., 9 miles S.S.W.; in 25° W., 13 or 14 miles W. by S.; in 31° W., 10 miles W.S.W.; in 33° W., 21 miles W.S.W.; in 35° W., 14 miles W.S.W.; in 37° W., 8 miles W.S.W.; between 39° and 42° W., 11 or 12 miles W.S.W.; between 42° and 45° W., 16 miles W. by S.; in long. 46½° W., 12 miles S.S.W.; in 48½° W., 11 miles W.N.W.; in 51° W., 7 miles W.S.W.; in 53° W., 4 miles W.S.W.; in 54° W., 18 miles West; in 55½° W., 15 miles W.S.W.; in 57½° W., 16 miles West; in 60½° W., 16 miles W.S.W.; in 62° W. (70 miles N.N.E. from Barbuda), 10 miles N.W.; and off Sombrero, 7 miles W.N.W.

The wind observed was about N.E., between the Canary Islands and 35° W.; thence East, with a little South in it as the Caribbee Islands were approached.

The temperature of the sea surface was 64° F. at the Canaries, and increased, as the voyage proceeded, to 75° at Sombrero. A temperature of about 46½° was found right across, at a depth of about 500 fathoms, and at 1,000 fathoms the temperature varied from 37° to 39°. Bottom temperature, 34° to 36°.

(304.) As it would be beyond the scope of this work to give a series of monthly charts, like those published by our Meteorological Office, although they are very interesting and most important, our remarks must be limited to those verbal extracts from that work, such as have been given previously.

*The Westerly Drift.**—Under this name are included the Currents of the vast central expanse of the North Atlantic Ocean, bounded on the East by the North African Current, on the South by the Guinea Current, on the West by the chain of the West India Islands, and the Northerly and North-Easterly portion of the Gulf Stream, and on the North by the Easterly part of the Gulf Stream.

The Westerly set may be considered to commence at the 30th meridian. From lat. 8° N., as its mean Southern limit, to the parallel of 20° N., the set is more constant and steadier than it is farther Northward. Indeed, as the latitude increases, the regularity of the set and the rate decrease. Here the latter averages from 12 to 24 miles a day, and this part of the Drift enters the Caribbean Sea with the Equatorial Current. Between the parallels of 20° and 25° N. the Drift averages from 8 to 12 miles, and can be traced to about long. 63° W. From 25° to 30° N. the set is irregular, and the rate from 4 to 1 miles, traceable also to long. 63° W. Between 30° and 40° N. the set is so irregular in direction and feeble in force as to lead to the conclusion that here the true Westerly Drift does not exist.

From lat. 36° N., long. 65° W., to the Bahamas, along the right edge of the Gulf Stream, we find evidence of a counter-current setting to the S.W., and then to the South, at about 12 miles a day; and about lat. 28° N., long. 78° W., turning to the S.E., in conformity with the contour of the Bahama Shoals. This South-Easterly Current is probably periodical, and seems at times to extend to long. 63° W., in lat. 34° N., its greatest rate not exceeding 15 miles a day. About long. 64° W., from lat. 20° to 27° N., there is a feeble Northerly set, but not supported by many observations.

(305.) In *January* the Westerly Drift of the North Equatorial Current seems confined to the Torrid zone, and to vary from 6 to 24 miles per day. There are indications of an Easterly Drift in lat. 23° N. Farther North the observations are deficient and conflicting, but indicate a Drift to the Southward of West.

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* By this term it is to be understood that what we call the *North* Equatorial Current or Drift is meant.

In *February* the vast central area of the Atlantic Ocean appears to have variable currents, judging from the very few observations recorded for February. The Westerly Drift of the Tropics, if it exists at all, must be very feeble, not averaging more than 8 or 12 miles daily. Between lat 30° and 37° N., long. 42° to 65° W., the Drift seems to be Northerly, but the observations are not numerous. (See, however, the remarks relating to H.M.S. *Challenger*, on pages 343—344).

In *March* it does not appear to extend beyond lat. 25° N. Between 27° and 55° W. observations fairly represent the general Westerly set, while they give its rate at from 6 to 35 miles; it has its greatest rates in lat. 5° N.

In *April* the Westerly Drift may be said to extend to 30° N. The observations differ greatly as to the rate, though they agree in indicating greater strength in the lower latitudes. In mid-ocean, between 30° and 40° N., the directions are variable, and the rates feeble.

In *May*, North of the Equatorial Current to lat. 30° N., and from 25° W. to the West Indies, the general movement of the ocean seems to be to the Westward, at a rate of from 6 to 18 miles. In the Western portion of this region observations are, as usual, deficient.

In *June* it appears in mid-ocean and towards the Bahamas. It does not extend Northward of 30° N. The rates are various, and the observations are altogether scanty, as they are for *July*, *August*, *September*, and *October*.*

In *November* it exhibits a decided set to the Southward, between 25° and 30° N., and 40° to 60° W.

In *December* the Westerly Drift seems to maintain its usual gentle flow, but from lat. 20° to 40° N., long. 40° to 70° W., there are scarcely any data.

(306.) In the work (before mentioned in the *note*, page 136) by Captain Toynbee, a very full discussion of the direction and strength of the Currents between 10° S. and 20° N., and from long. 10° to 40° W., is given. Any verbal description of this work would give but a poor idea of its utility, and it has been thought best to give the information in the diagrams relating to the Best Monthly Routes Across the Equator, given hereafter, to which therefore the reader is referred.

(307.) It will be scarcely necessary to recapitulate the evidence upon which the mean rate was set down in the chart of the North Atlantic Ocean, before referred to (see (48) page 128). The General Chart of the Currents, at page 295, will, with the foregoing remarks, fully explain this part of the subject. As the Current is well established, we need not extract the numerous observations given by Captain Maury, as they almost all tend to the same conclusion. But the Drift of Bottles is so marked an evidence, that we give a number of instances which will be very instructive.

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* Between September 4th and 10th, 1887, in lat. 23° 30′ N., long. 34° to 48° W., Easterly and South-Easterly currents, of 7 to 21 miles a day, were experienced by three ships of the United States training squadron, where a decided Westerly drift is almost invariably reported. On the 11th, this Easterly set was lost, and the usual drift (W.N.W., 18 miles,) met with. The Trades were fresh, with no unusual meteorological conditions.

(308.) **Bottles.**—The following have been selected from Captain Becher's list, explaining his Bottle Chart, in the "Nautical Magazine," of November, 1852. It has been before quoted in (243), pages 295—296:—

Ship.	Signature.	Where left.			Where found.	Interval Days.	Distance in Miles.	Rate per Day.
		Year.	Latitude N.	Long. W.				
			°	°				
Thunder	Owen	1833	28·4	25·5	Bahamas	506	2750	5·4
Osprey	....	1822	13·3	39·2	Bahamas	216	2610	12·1
C. Dunmore	Robertson ...	1828	27·4	28·0	Cuba	437	2530	5·8
Kate	Creswell ...	1825	24·0	19·0	Mosquitia	519	3300	6·3
Wellington	Liddell	1836	17·9	29·0	Abaco	265	4000	15·1
Echo	Belcher	1837	17·3	36·6	Antigua	196	1410	7·1
Stratford	Locke	1836	14·5	34·4	Jamaica	278	2460	8·9
Osprey	....	1820	4·1	24·3	Barbadoes	139	2220	16·0
William Lockerby	Parker	1838	14·1	25·2	Grenadines	169	2110	12·4
Osprey	....	1820	5·2	24·7	Martinique	322	2300	7·1
Osprey	....	1822	6·2	15·6	Trinidad	192	2920	15·2
C. McCarthy	Field	1824	22·0	53·5	San Salvador ...	226	1200	5·7
Harlequin	Cunningham	1851	24·7	30·4	Turks Island ...	300	2300	7·6
Calliope	Kuper	1843	19·2	30·8	Caicos	375	2250	6·0
Two Brothers	....	1826	C. Verde Islands		Crooked Island	382	2800	7·1
Duke of Marlboro'	Thorn	1820	C. Verde Islands		Hayti	283	2610	9·2
Nisus	Rey	1842	14·5	34·4	Martinique	277	2100	7·6
Mary	Locke	1836	14·5	34·4	Barbuda	278	1700	6·0
Enterprise	Collinson ...	1850	1·1	26·8	Honduras	367	3800	10·3
Investigator	McClure ...	1850	12·4	26·1	Ambergris Kay	186	3610	20·0
Rapid	Messum	1852	0·5 S.	22·6	Martinique	155	2430	15·6
Sophia	Saxon	1848	5·2	40·3	Grenada	151	1320	8·7
Race-horse	Home	1835	8.6	52·0	St. Vincent	35	610	17·4
Race-horse	Home	1835	1.3	47·8	Tobago	50	1000	20·0
Race-horse	Home	1835	11·5	61·5	Maracaibo	17	240	14·0

The mean rate of travelling of all these Bottles is 10·6 miles per day. But this average requires several qualifications which will make it considerably higher. The distances are measured *direct*, but it is most probable that these messengers pursued a more or less *devious* course. Again, it will be seen that the Bottles thrown out on the Northern part of this Trade Wind drift have travelled much slower to their destination than those which started from near the Equator.

(309.) Besides the above, we add the following examples of Bottle drifts:—

Central Drift to the Virgin Isles.—A Bottle from the *Emerald*, Captain Nockells, bound to Jamaica, December 17th, 1831, in lat. 36° 40′, long., by chron., 12° 32′. Found on the North side of Anegada, January 8th, 1833. The winds for the last three days, previous to the 17th of December, were from North and N.W. to S.W. For eight days preceding these it blew a continued and heavy gale from S.W. and W.N.W.; the barque lying-to the whole time, and drifting from lat. 41° 28′, 227 miles to the Northward.

Equatorial Current to Tobago.—A Bottle from the schooner *Julia*, William Davidson, master, in lat. 6° N., and long. 40° W., November 6th, 1821. Found March 7th, 1822, near the shore of Little Rocky Bay, Tobago.

Central Drift and Equatorial Currents.—A Bottle from the ship *Gambia*, in the River Gambia, lat. 13¼° N., in the latter part of 1831, was picked up on the Southern side of Virgin Gorda, lat. 18° 30′.

Central Drift and Equatorial Currents.—A Bottle from the *Two Brothers*, of Baltimore, in lat. 17° N., long. 26° W. (off St. Antonio), November 21st, 1826, was found at Acklin or South Crooked Island, in lat. 22° 12' N., long. 74° 18', on December 8th, 1827. Hence it appears to have drifted, in a W. by N. direction, from the vicinity of the Cape Verde Isles to the West Indies, under the influence of the drift from the N.E. and the Equatorial Current, probably, in the first instance, W.S.W. and thence W.N.W.

Madeira to the West Indies.—A Bottle from the ship *Symmetry*, of Scarborough, Captain Smith, on her way from Leith to Buenos Ayres, off Madeira, June 9th, 1825. Picked up at Salt Kay, Turks Islands, after a lapse of ten years, June 9th, 1835.

Cape Verde Islands to Brasil.—The *Hazard*, of Greenock, August 4th, 1812, lost the N.E. Trade in lat. 11° N., long. 25° W.; and the wind, until the 12th, varied from West to S.W.; from the 12th to the 17th it generally blew from South, never exceeding one point Easterly. Gained the S.E. Trade on the 17th, in lat. 2° N., long. 27° 30' W.; the Trade kept Southward between Peñedo de San Pedro, or St. Paul's Islets, and the coast of Brasil (at Rio Doce), and experienced a Westerly current amounting to nearly *four degrees.* Attested by Captain J. W. Monteath.

Between Madeira and Brasil.—In the *Jane*, Captain Livingston, April and May, 1824, found a surplus effect of currents, between Madeira and Brasilian Trinidad in thirty-nine days, equal to 1° 19' 47" S., and 6° 8' W.

A Bottle from the ship *Hesperus*, about lat. 37° N., long. 28° W., May 12th, 1878, was picked up at Mobile Bay, May 22nd, 1880, having covered a distance of about 5,500 miles, at the mean rate of 8 miles a day.

A Bottle from the ship *Patriarch*, in lat. 18° 29' N., long. 27° 8' W., December 23rd, 1884, was picked up in 1887 (? date), on the Eastern side of Caicos Bank, having drifted 2,528 miles to W. ½ N.

(310.) The foregoing is a sufficient elucidation of the features, velocity, and limits of the N.E. Trade Wind Drift of the Atlantic Ocean, but, as before mentioned, particularly in (53 to 60), pages 131—135, the division between the Northern and Southern systems of Wind, and consequently of Current, being to the Northward of the Equator, the South Equatorial Current ultimately combines with the North Equatorial Current, part of their united waters entering the Caribbean Sea, and forming the origin of the Gulf Stream, and the rest appears to trend off to the Northward outside the islands, as explained hereafter, in the Section dealing with the Gulf Stream.

6.—THE SOUTH EQUATORIAL CURRENT.

(311.) The South Equatorial Current, which passes over the Equator in its Northern portion, in its direction is, like that of the Northern Equatorial Current, nearly due West. Setting upon the Northern coast of South America, it runs with great velocity close in-shore at times, sometimes reaching 100 miles per day, and not unusually 60 miles. It is scarcely necessary to dilate on this Current, as it appears to be regularly and constantly met with. Arrived to the Northward of Tobago, it combines with the North Equatorial Current, and the united streams thence proceed as described above. Its progress through the Caribbean Sea, &c., will be dealt with in the next Section. For an idea of its strength and direction in the Equatorial region, between the longitudes of 10° and 40° W., the reader is referred to the diagrams illustrating the Best Monthly Routes Across the Equator.

(312.) It will be seen that, throughout the breadth of this Ocean, the set of the stream is not to S.W. or N.W., as might be expected from the direction of the Trade Winds, which may be taken as the prime mover of these mighty drifts, but *Westward*. This fact would seem to indicate that the rotation of the earth on its axis has more to do with its motion than has usually been attributed to it. But our present knowledge of the subject is not sufficiently extensive or accurate to define what amount of action is due to that source, or how much to the wind, lunar influences, or temperature, all of which combine to produce the phenomena we are considering. Theoretical speculations, however, are not necessary in a practical work, although they may be interesting.

(313.) In the "Sailing Directory for the Caribbee or West India Islands," by A. G. Findlay, will be found "Remarks on the Currents of the Atlantic and West Indies, made by Lieutenant A. H. Bisschop Greevelink, in the *Echo*, a brig of the Dutch Royal Navy, during four years of service, 1833—1837," and which describes the route of that vessel from England to Surinam, in August and September, 1833. "On the evening of the 13th of the month, the *Echo*, having arrived in lat. 17° N., and long. 35° W., lost the Trade Wind, and the wind then shifted to the N.W., with a strong breeze; gloomy weather, and much rain, during the twenty-four hours. The following day the wind, diminishing, passed to the S.W. and S.S.E., and terminated in a calm; currents weak and variable to the S.W. and Eastward.

"On the morning of the 16th, in lat. 14° 40′, long. 30° 20′, a light breeze sprang up from the S.E., and from that time till we reached the coast we had to struggle with a never-ceasing variety of wind and weather, continual rains with squalls, and scarce a day passing without lightning in one or other quarter of the horizon. On the 18th we passed by several ripplings or eddies, being then in lat. 12°, and long. 39° 30′ W. They usually stretched from East to West, and were often seen to cover the whole surface, everywhere boiling and bubbling as in a cauldron. Current always weak, and during the last forty-eight hours to the West and W.N.W. at a rate of half a mile an hour.

"After losing the Trade Wind we had to creep over more than 900 miles, as the wind had left us, in every appearance, for ever; the rains were copious and continual in this space, and lightning was seen very frequently. On the 18th (lat. 11° 52′, long. 39° 25′), we passed through a number of eddies; and on the 24th (lat. 8° 3′, long. 45° 37′), the first indication of a change in the colour of the sea became visible; yet it was slight, and may be attributed to a branch of the Northerly current observed in the succeeding day. On the 27th (lat. 5° 52′, long. 48° 38′), we received a gentle S.E. breeze, which brought us, though slowly, toward the coast. In the night of the 28th (lat. 5° 7′, long. 49° 56′), we crossed the edge of meeting currents from the Ethiopic Ocean and Brasilian shore, and from the Marañon; after which, we entered the boundary of the tides. In the evening of

September 30th, came to anchor in 5¼ fathoms. In the night, observed longitude by chronometer, 54° 11′ 45″.

"Although we had not seen land since we lost sight of the Lizard, by which to examine our timekeepers, I felt not the least doubt about their rate (the one a *Knebel*, and the other a *Parkinson and Frodsham*), by their reciprocal conformity, corroborated by my lunar observations (which, by-the-bye, I think are never to be neglected); and as I was desirous to obtain some observations about the Currents, so peculiarly remarkable in these seas, I took every opportunity which circumstances allowed to satisfy my curiosity.

"On the 22nd of September and subsequent days, the ripplings became less in number; and on the 24th, in the afternoon, about the 8th degree of latitude and 46th of longitude, we perceived the first change in the colour of the water from the common blue to a somewhat darker hue; and, as this was somewhat an uncommon case, I attributed it to a branch of Current observed the following day at noon, setting due North, at the rate of more than a mile an hour, straight across a South-Easterly Current observed during the preceding days, mingling the muddy waters of the Marañon and other rivers with those of the ocean. From the 24th to the 28th nothing particular occurred; we were always steering to the S.W. with light variable winds, and a continuance of rain sufficient to penetrate our very bones. Currents, weak and changeable, being lastly observed to run N. by W., 18 miles in twenty-four hours. This, at present, I call weak, being afterward accustomed to fall in with a velocity of twice and thrice that number of miles. At noon we altered our course to W.S.W., being then in lat. 5° 7′, and long. 49° 45′ 55″.

"In the night, however, having a lunar altitude, we were not a little surprised at finding the ship thrown 35 miles to the Northward of her supposed situation, although I may say to have been prepared for this occurrence by Captain Edward Sabine's relation in the "Memoir," whose track we were crossing just then, in the same month.

"At break of day we saw the water totally altered in colour, and thickly mingled with mud, as if we were sailing in a flood of ochre; hove the lead, and found 45 fathoms, fine sand, white and black. At seven in the morning, by chronometric observations, I found the Westerly offset 33′ 38″; and finally, at noon, in lat. 5° 21′ 49″, long. 51° 46′ 15″, it appeared evident that the Current, in the last twenty-four hours, had been running with the rapidity of 67 miles to the N. 30° W. In the afternoon we perceived the land toward the S.W. by S., being the *Family Islands* of Cayenne, and at the same time we entered the boundary of the tides.

"This, indeed, seems to confirm the opinion of those seamen who attribute the principal strength of Currents hereabout to the waters of the Marañon, &c., predominating over those of the ocean; but this is to be admitted in a partial degree only; for, as operating on the general direction of the Equatorial Current, I esteem it as of no influence at all."

(314.) The numerous voyages made by the *Echo*, in the West Indian Seas, with a particular detail of each, more especially in regard to the Currents, are given in the volume before mentioned; and from these voyages and experiments the general inductions are, that between the Caribbee

Islands and the Coast of Guayana, in the months of August, September, and October, the Current veered to the Northward of N.W., and in other months more Westerly, or even to the Southward of West, as in November and December, 1834; but we learn, also, that the greatest velocity of Current has been observed in August and September, when the Marañon is at its lowest level, as well as in December and March, when this river begins to increase, and attains its greatest height; even on examining the details, in order to discover any regularity in its force, we find an irregularity reconcileable only with that of the wind; and, more generally, by applying the theory of Trade Winds, and their influence upon the surface water of the Ocean.

After having once rebounded from the Brasilian Coast, the united Equatorial and Ethiopic Currents are again compelled to retire Westward by the influence of the S.E. Trade Wind (apparently, also, by the disposition of the waters in these regions to retire Westward); and, although at passing the Marañon, which disembogues towards the N.E., the combined Current may, in some degree, according to its variable form and strength, derive an impulse to the Northward, yet it soon yields to the force of the N.E. Trade Wind, and the South-Westerly Drift thereby produced, which sets toward the Caribbee Islands.

In proportion to the force and extent of these winds, the general current is pressed toward the shore of Guayana, as in December, 1835, and November and December, 1834; or allowed to expand freely to the North, as in August, September, and October; even to the N.E., as in March, 1837, especially when preceded by long and violent indraughts, and followed by calm weather.

By the influence of the Marañon waters, the general Current is prevented from sweeping the coast to the Westward of Cape North; as the stream of this great river, being unobstructed, seems to gather all its strength, and force the Western boundary of that gigantic drift to an uncertain distance from shore. In this manner we may account for the weak Westerly Current, creeping along that part of the coast comprehended between the Marañon and Gulf of Paria, called the *region of the tides*, and which is produced by the remaining effluxion of the Marañon, confined between the Western border of the general Current and the muddy banks of Guayana. It is incorrect to fix this border in 9 fathoms, as I have found it in twice and thrice that depth; but, on the other hand, I think that if what has been supposed by Admiral Cosmé de Churruca should ever happen again—I mean the destroying of the Equatorial Current by the action of the rivers—the Atlantic will be found of a whitish hue, so far as these Currents shall reach, because their thick muddy waters never mingle with those of the ocean until they have been subdued by, and are at rest with them.*

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* The great force of the Marañon current was observed by Captain W. Code, in the ship *Albion*. He says:—On October 8th, 1857, at noon, lat. 5° 14′ N., long. 50° 1′ W., current North, 18 miles. This current must be caused from the waters of the River Marañon. The water is not salt, merely brackish taste, the sea boiling and making a great noise, which I have found seldom to occur when the currents are strong.—"Meteorological Report," 1872, page 30.

(315.) H.M.S. *Challenger* (August 21st—September 6th, 1873) crossed the South Equatorial Current from lat. 3° 25′ N., long. 15° W., 420 miles W.S.W. from Cape Palmas, to Cape San Roque; visiting on the way St. Paul's Rocks and Fernando Noronha. She found the Currents much as represented in the illustrative diagram, page 295, but having generally a greater velocity; thus, in lat. 3° 25′ N., long. 15° W., the Current flowed 9 miles to W.S.W. in the twenty-four hours. Thence she steered direct for St. Paul's Rocks, and in long. 17° 30′ W. found the Current setting 23 miles to the N.W. in twenty-four hours; in long. 20° W., 20 m. W.N.W.; in 22° 30′ W., 17 m. N.W.; in 24° 30′ W., 26 m. W.N.W.; in 26° 30′, 21 m. W. by N.; in 29° W. (50 miles E.N.E. from St. Paul's Rocks) the high velocity of 39 m. to W. by N. was found; at 70 miles S.W. of St. Paul's Rocks, 29 m. W.N.W.; midway between St. Paul's Rocks and Fernando Noronha, 25 m. S.W.; near Fernando Noronha, 21 m. West; at 60 miles S.W. of Fernando Noronha, 27 m. N.W.; at 90 miles East of Cape San Roque, 30 m. W.N.W.; and on the coast of Brasil the Currents were generally found flowing to the N.W. and West, as far as 15° S.

The wind at the commencement of this passage blew from the S.S.E., but afterwards came more from the Eastward. At Cape San Roque its direction was from the S.E., varying in force from 3 to 5 (Beaufort scale, see page 104). The temperature of the surface water observed in this passage varied from 77° to 78°. At a depth of 10 fathoms in the Eastern and central part of the region traversed, the temperature of the water was 78°, while near St. Paul's Rocks at this depth it was only 77°, and near Fernando Noronha only 75°. At 50 fathoms, in the central part of the district, it was 62° to 63°, and in the Western 67°. At 100 fathoms the temperatures were from 55° to 57°, and at 1,000 fathoms 36° to 37°. The higher temperature at 50 fathoms in the Western than in the Eastern part of the district, seems to indicate the banking up of the warm water to the Westward by the prevalent wind.

(316.) On this Current the following is extracted from Mr. R. Strachan's remarks in the Meteorological Report, 1872:—

The South Equatorial Current commences on the African coast, and seems to extend at times as far as to 3° N. lat., though more commonly here it is not found beyond 1° N. To the first meridian its rate is from 12 to 17 miles. It now extends generally to lat. 3° N., and maintains this limit to long. 25° W., during a course nearly West of over 1,500 miles, at rates changing from 26 to 12 miles per day. It now has a tendency to the N.W., and attains lat. 6° or 7° N., and, as a general result, maintains this limit until it reaches the coast of Brasil. Near the Equator the mean rate is less than 24 miles per day, and this becomes lower as the latitude increases, so that in lat. 5° N. its velocity is less than 18 miles. For nearly 300 miles from the coast of Brasil and Guayana the direction of the Current is affected by the land. Off Brasil, the rate is from 62 to 37 miles per day; off Guayana, it is from 31 to 24 miles. Having passed the 50th meridian, the Northern edge merges with the Westerly Drift of the North Equatorial Current, though in some months this is effected in longitudes more to the Eastward, even so far as the meridian of 25° W.

(317.) Commander J. R. Bartlett, U.S.N., from examinations made in the surveying steamer *Blake*, in 1879, concluded that "the Equatorial Current, which sets directly against the Windward Islands, is by them and their connected ridges deflected Northward, and so following their outer edge passes around the Virgin Islands to the Westward and through the deep channel to the Northward of San Domingo." He suggests, also, that on reaching Cuba the current divides, a part flowing N.W. through the Old Bahama Channel, and a part through the Windward Passage between Cuba and San Domingo, and thus by Cape San Antonio into the Gulf of Mexico.

He also remarks:—"The Current, always found flowing North along the Eastern side of South America, on reaching Tobago divides, part joining the Equatorial Current setting North along the chain of islands; the remainder following the coast-line of Trinidad and the Spanish Main, and so around the entire circumference of the Caribbean Sea, finding at last an outlet at the Mona Passage and Anegada Channel, to join the Equatorial Current on its way to the Gulf of Mexico."

Both these theories are quite contrary to that founded on later investigations made in the same vessel by Lieutenant Pillsbury and other officers. Professor Alexander Agassiz, who accompanied Commander Bartlett, says:—"In the present state of our knowledge it is difficult to trace the path of the Equatorial water as it is forced into the Eastern Caribbean."*

(317.) Lieutenant Pillsbury states that, from his observations, the Current caused by the S.E. Trade Wind sets towards the Windward Islands with varying strength, and leaves the island of Tobago with a course about N.N.W., joining the current caused by the N.E. Trade S.W. of Barbados. The united flow is then between the islands, the strongest being in the passage South of St. Lucia, and lessening in velocity in the passages to the Northward as the latitude increases. Beneath the Westerly surface current in these passages is an underflow setting out to the Eastward.

(318.) **Bottles.**—A bottle from the ship *Patriarch*, in lat. 12° 47′ N., long. 24° 47′ W., December 20th, 1884, was picked up afloat at Colon, February 1st, 1886. It had thus traversed a distance of about 3,500 miles in 408 days, or at the rate of over 9 miles a day.

A bottle, thrown from the steamer *Patrician*, December 12th, 1887, in lat. 1° 10′ S., long. 27° 3′ W., was picked up February 10th, 1888, in lat. 2° 19′ S., long. 42° W., a drift of about 900 miles to W. ¼ S. in 60 days, at the rate of 15 miles a day. (See Drift diagram, page 297).

A bottle, thrown overboard off Pernambuco, Brasil, July 28th, 1885, was picked up on the beach at Little Cayman Island, West Indies, March 1st, 1888, where it had probably lain more than 2 years.

(319.) An example of an extraordinary velocity on the Northern edge of this Current is given by Captain W. Code, ship *Albion*: 1857, from August 5th, noon, lat. 0° 36′ N., long. 43° 21′ W., to 6th, noon, lat. 1° 51′ N., long. 45° 59′ W., experienced a Current of N. 72° W. 73 miles, although not the slightest rippling or agitation of the sea was visible.

On the 7th, at noon, lat. 3° 50′ N., long. 48° 40′ W., the Current was found to have been N. 61° W. 108 miles. Surprising current; measured log lines and log glasses which are correct, so there is no doubt that the current has carried the ship the distance noted.

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* "Three Cruises on the United States Coast Survey Steamer *Blake*, 1877—1880," by Alexander Agassiz, 2 vols., 1888.

7.—THE CURRENTS OF THE COLOMBIAN OR CARIBBEAN SEA, THE GULF OF MEXICO, ETC.

(320.) We have previously mentioned (302) that the combined streams of the North and South Equatorial Currents impinge upon the Eastern side of the Caribbee Islands, and some part passing to the Westward through the channels between them causes the Westerly Drift through the Caribbean Sea, which is not so persistent as it is in the Ocean to the Eastward, as will be presently explained. We first give particulars of the currents in the channels between the islands, and then proceed to describe those within.

(321.) In all the passages of the Windward Islands a Westerly surface inflow prevails to a greater or less extent, but in those on the Northern side of the Caribbean Sea there is no fixed current. In addition to this flow there is a large volume of water entering all the passages from the break of the waves.

Mr. R. Strachan, in his observations upon the Meteorological Office Current Charts, 1872, states that the Westerly Current, which enters the Caribbean Sea, has a rate of 37 to 46 miles a day North of Trinidad, but the rate decreases in the other passages as the latitude increases, and in lat. 17° N. it is only 12 miles a day.

In *Grenada Passage*, between Trinidad and Grenada, according to the Spanish *Derrotero de las Antillas*, &c., the Current has been found to set nearly West; on the South side half a point Southerly, and on the North side half a point Northerly, its velocity being from 1 to 1½ and 2 miles per hour. Commander Heyerman, U.S.S. *Yantic*, January 28th, 1888, in proceeding from lat. 11° 59′ N., long. 60° 52′ W., to Port of Spain, Trinidad, found a current of 2¾ knots an hour setting W. 1° S.

Observations taken in February, 1889, by the United States Coast Survey steamer *Blake*, tended to show, however, that there was no permanent Westerly current in this passage, but that the surface currents were variable, with an under-current setting out to the Eastward, at a considerable depth. This deep under-current was also found in the passages to the Northward. Between Tobago and Barbados the mean direction of the surface current was North, although the Trades were blowing with a force of 2 to 7 Beaufort Scale.

Between Grenada and St. Vincent, among the Grenadines, the Currents are devious; but the general inset appears to be W. by N.

In St. Lucia Passage, between St. Vincent and St. Lucia, the Current sets in from the Eastward, but runs more Northerly; and within, on the

West, it has been found setting to the N.W. Its velocity was found to be greater here than in the passages more to the Northward, as already stated At some distance below the surface the *Blake* found a tidal current, below which the water set out to the Eastward.

In *Martinique Passage*, between St. Lucia and Martinique, the current has been found to run nearly North, but very variable on the Western side of Martinique.

The U.S.S. *Kearsarge*, on March 19th and 20th, 1889, to the South-Eastward of Barbados, found a South-Easterly current, of 30 and 20 knots a day respectively; on the 29th, between Barbados and Martinique, the current set due North, 10 knots in 14 hours; and between Martinique and Santa Lucia, 4 knots in 1 hour, and 8 knots in 4 hours.

In *Dominica, Guadaloupe, and Antigua Passages*, there is usually a gentle Westerly current. In Dominica Passage, between Martinique and Dominica, it has also been found to run nearly North, and between Montserrat and Antigua N.W.

At the distance of about 60 miles, *within* (or Westward of) *the range of the Caribbee Islands*, and to the Virgin Islands, the Current has been found setting, in general, to the W.N.W., from 1 to 1¼ mile an hour. On the leeward side of the Virgin Isles devious currents are found, frequently to the South-Eastward. The same have been observed on the Western side of St. Christopher's, &c.

(322.) *On the Northern coast of Hayti*, and in the *Windward Passages*, there does not appear to be any general Current. On the North side of Cuba the case is nearly the same; but in the channel there is a regular tide throughout the year, subject, however, to certain variations.

In *Anegada and Mona Passages*, the *Blake* found irregular and weak tidal currents, with probably a slightly preponderating current out of the Caribbean Sea on their Eastern sides, and into it on their Western sides.

Other observers state that in *Mona Passage*, between Porto Rico and Hayti, the Current has been marked as frequently setting to the N.W., and we have instances of a set through to the S.W.; but Captain Monteath, in February, 1816, when proceeding Southward toward Porto Rico, from lat. 23½° to 22°, long. 64° to 65°, found the Current setting N.N.E. at the rate of 20 miles in the 24 hours; and he says, that off the N.W. point of Porto Rico it invariably sets from the Caribbean Sea to the North and N.N.E. On the Western side of the passage it set North, 2 miles an hour; but there have been instances of an inset from the N.W.

In the *Windward Passage*, between Hayti and Cuba, the *Blake* found the currents to be the same as in Anegada and Mona Passages, but more decided in velocity, probably depending upon the strength of the wind.

In the *Bahama Passages* the Currents are devious; both weather and lee currents having been found. These, also, appear to be influenced by the tidal causes; for the tides are operative on the banks, and sometimes set strongly.

In *Bahama Old Channel* and *St. Nicolas Channel* the current has been found to run North-Westward and South-Eastward, its direction depending mainly upon the prevailing wind. In *Santaren Channel* it is very weak and irregular.

(323.) *Bahama Islands.*—The following remarks by Captain W. C. Berry are extracted from Captain Maury's "Sailing Directions," 8th edition, vol. ii., page 19. He says:—"Having had long experience in the trade between New York and New Orleans, I herewith furnish you with a few remarks on Winds and Currents. For the last six years I have commanded the ship *Vicksburgh*, constantly trading between these two ports. In making the passage out, after passing the Hole-in-the-Wall, I have frequently found a Current, from 1 to 3 miles per hour, setting to the Eastward through the *N.W. Providence Channel*, particularly after the wind has prevailed from the Westward a few days. This, no doubt, has been the cause of putting a number of vessels on shore among the Berry Islands. I have latterly made it a point to take the last bearings of the light on the Hole-in-the-Wall, and either haul up or keep off as I found the current; generally running on a West course until quite down with Little Stirrup Kays, then steering W. by N. ½ N., by compass, if in the night, until I was up with the Great Isaacs."

(324.) Lieutenant G. C. Hanus, U.S.S. *Enterprise*, states that in November, 1890, when off the Bahama Islands, a current of about half a knot an hour was found, setting W.N.W. Between Castle Island and Cape Maysi, Cuba, the current encountered was slight at first, setting to the Westward, but, on approaching Cape Maysi, and after sighting the light, a current was found of about 1½ knot per hour setting to the Westward, and gradually decreasing in force until after the light bore West, when the current changed to the Southward and Westward with gradually diminished force.

(325.) *Of the Currents in the vicinity of Anegada and the Virgin Islands*, Sir Robert Schomburgk says:—

"It is well known that the Tropical Current, caused by the earth's rotation, sets to the Westward, and its grand movement in these latitudes is directed through the Caribbean Sea; but it is probable that a branch of it, turned aside by the North-Eastern coast of South America, sweeps along the Caribbean Islands to the N.W. till it reaches the Bahamas; and it is this branch which at present attracts my particular attention, and in proof of the existence of which I adduce the following remarks:—

"Vessels bound from America to the West Indies, and chiefly to St. Thomas's, frequently find themselves to the North of the Virgin Islands; and this deviation from their intended course has but too often proved fatal, having brought them on the reefs of Anegada when they thought themselves far to the Southward of that dangerous island. Nor can repeated occurrences like these be attributed exclusively to errors in the observations for determining the latitude, or to false reckoning."

The American brig *William and Thomas* left New York October 28th, 1829; made Bermuda on the seventh day after her departure, when, contrary winds retarding her course, land was discovered in the morning of November 15th. According to reckoning, it was supposed to be St. Martin's, but it was fortunately known, on approaching, to be Virgin Gorda, or probably, in the night, the vessel would have gone on the reefs of Anegada.

The English brig *Francis*, bound from Nassau, in New Providence, to Trinidad, cloudy weather having precluded an observation for several days, was supposed to be far distant from Anegada; but making land in the evening, supposed to be St. Martin's, was wrecked at 11 p.m. on the reefs of Anegada.*

The American brig *Lewis*, bound from Philadelphia to St. Thomas's and Maracaybo, and supposed on the day previous to be on the parallel of St. Thomas's, was wrecked on the South-Eastern reef of Anegada, April 9th, 1831.

During his continuance at Anegada, Sir Robert Schomburgk acquired additional proofs of the existence of a North-Westerly Current. He found on the South-Eastern reef several buoys with tyer (coir) ropes attached to them, which appeared to have come from St. Martin's. On September 24th, 1831, after a severe gale, two buoys were found on the same reef, which had probably been attached to anchors on some ground to the S.E.

On sounding between Virgin Gorda and Anegada, Sir Robt. Schomburgk threw the log every thirty minutes, and, taking bearings of some remarkable objects, the drift was found to be always Westerly; and the result appeared to be the same whether the tides set North or South. On one day he left his anchorage, and sailed 10 miles to the Northward of Anegada, where the boat was lowered, and rendered stationary by means of a kettle filled with stones, it being then Southern tide; in spite of which the log was carried N.W. by W. A similar experiment was made in the waters between Virgin Gorda and Anegada, with the advantage of anchoring; and the set was always the same, the drift being nearly 1 knot.

The North-Western or ebb tide between Anegada and Tortola is much stronger than the flood to the S.E.; undoubtedly from the circumstance that tide and current work the same way.

On these circumstances Sir R. Schomburgk observes, that the wind, from March to June, frequently blows from the South and S.E., and the velocity of the N.W. Current will be thus increased; in consequence of which, vessels bound during that time for these islands are more subject to error in their course than at any other period; and lighter bodies being more influenced by the currents than heavier ones, may be taken as the specific cause of the last remark.

(326.) The *Rollers*, or *Heavy Ground Swell*, off the North-Eastern portion of the Antillas, which has from time to time produced so much mischief, was first described by Sir R. H. Schomburgk, as shown in the Journal of the Royal Geographical Society, 1835, to which the reader is referred for a complete explication of the subject.

The phenomenon appears to be caused by the meeting and combination of the Drift from the N.E., and the Equatorial Current from the S.E. or E.S.E. It rises, rages, and subsides, says Sir R. H. Schomburgk, when the air is calm, when there has been no indication whatever of a previous gale, or even when light airs have, for a considerable period preceding, come from the Southward of East. The waves approach in gentle undulations, but suddenly swell against the shore, and break with the greatest impetuosity. The rise takes place sometimes gradually, but more frequently quite unexpectedly, the waves reaching an uncommon height.

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* A great quantity of cork shavings are annually washed ashore on the North side of Anegada. They are considered to be drifted by the Equatorial Current from the coasts of Spain and Portugal.

A heavy "Ground Sea" is distinguished by something grand and sublime. The sea approaches in undulating masses, which suddenly rise to large ridges, crested with foam, and form billows that burst upon the beach with the greatest impetuosity; the spray flying, where the waves dash against cliffs, often more than 100 feet high, attended with loud roarings resembling thunder, which subside into a rumbling noise, caused by the nodules and fragments of rock with which the breaker was charged when advancing, which on its retreat roll backward, and are again driven forward by the next surge. Wave then follows upon wave in quick succession, there being, apparently, only a short interval after the third. The sea, for many miles from shore, assumes a peculiar aspect, different tints of blue, from the lightest to the darkest, forming a strong contrast with the snowy foam of the breaking waves, when they strike against a hidden rock, or with the white line visible along the whole coast. The Eastern Bahamas, the North-Eastern coast of Jamaica and Hayti, but chiefly Porto Rico and the Virgin Islands, and, in a less degree, the Northern Caribbee Islands, are subjected to this Ground Sea.

It may be considered, as a rule, that whenever the wind gets to the Northward of East for a day or two, there will be a *Ground Sea* on the Northern side of the islands. The friction of the wind on the surface of the water causes little elevations or ridges, which, by continuance of the force, gradually increase, chiefly when the wind sweeps over a great extent of water. Finding no resistance, and having sufficient depth to sink directly down, they proceed with the direction of the wind, and remain natural waves, until they meet repercussion from dashing against the shore, when they rise to an elevation much above their natural state.

The period when the Ground Sea sets in is generally in *October*, and it continues, though with some intermission, till April and May. The wind accompanying or preceding a Ground Sea is, generally, from the East of North; the waves are, therefore, propelled, more or less, in a Western as well as Southern direction, and the Bahamas, and even Bermuda, may escape, whilst the islands from Barbadoes to Porto Rico, but more particularly the latter and the Virgin Islands, receive their first impulse.

A Southern gale will likewise produce a heavy swell on the Southern side of these islands; and, during the gale of August 30th and 31st, 1833, this was felt with great violence on the Southern shore. But, generally speaking, neither in force nor duration are these surges to be compared with those of the Northern side; the group of the Virgin Islands being protected, in this direction, by the Caribbee Islands or by the Colombian coasts, and not exposed to the swell of the main ocean.

To one who crosses during a severe Ground Sea, from the Southern side of Tortola to the Northern, where the breadth of the island is inconsiderable, the singular spectacle is afforded of the sea, which on the Southern side is perhaps "as smooth as glass," on the Northern shore tossing, foaming, and roaring, as if agitated by a severe gale. The effect is most curious, and if it were not for the warning that is heard long before the cause becomes visible, one might fancy the wand of a magician in action.

The Northern coast of Porto Rico is subjected to a Ground Sea, of scarcely less force, and which has had the same effect on its coast as that of the Virgin Isles. The old "English Pilot" observes, that the sea along the North coast of Porto Rico "beats sometimes very ragingly." The force of the waves that batter against the cliffs on which the Morro stands is amazing; and any observer will admit that the spray is sometimes carried more than 100 feet high. It has been said that, several years ago, a brig, in consequence of carelessness, here became unmanageable, and was soon dashed to pieces against the cliffs, but few of the crew escaping.

(327.) **Caribbean Sea.**—Within or Westward of the Windward Islands there is a prevailing Westerly drift, weak and uncertain in the Eastern part of the sea, but gradually increasing in strength to the Westward. This drift, passing from the Atlantic through the Caribbean Sea into the Gulf of Mexico to feed the Gulf Stream, is not nearly so constant nor so strong as might be argued, *a priori*, from the apparent magnitude of that mighty current. Not only is it inconstant even in the mid-channel, but it is diverted by local causes and land configurations into opposite directions, as hereafter is shown to be the case along the Colombian coast and in the great Bays of Guatemala and Honduras. It appears to combine with the Tides in some degree, especially about the coasts of Cuba, Jamaica, and Hayti.

Upon referring to the description of the Guinea or Equatorial Counter-Current, as recited in pages 325 to 334, it is shown that it extends much farther to the Westward, during the period when the sun is in Northern signs. The Western extension of the Guinea Current, coincident with the increase of the Belt of Equatorial Calms (75), page 152, and (83), page 158, may owe its origin to the same causes, hitherto almost unexplained, as those to which this uncertainty of the Westerly Drift across the Caribbean Sea is owing.

Whether it is owing to the influence of the moon and the Tide, the effect of barometric variations and distant and local Winds, or of Temperature and the changes of the seasons, or of some hitherto unexplained effect of the earth's rotation, has yet to be argued. It is probable that hereafter a systematic examination of these apparently contradictory phenomena will lead to some important conclusions in the general subject of Meteorology.

(328.) Mr. R. Strachan, from his investigations, found the average daily Westerly drift in this sea to be about 20 miles. In the Spanish *Derrotero de las Antillas* it is stated that in crossing from the Southern coast, or from Cartagena, to the Northern islands, it has been discovered that from La Guayra to the Eastern part of Hayti, on a voyage made in December, a difference of 106 miles to the Westward was found during the seven days the voyage lasted.

(329.) Lieutenant G. C. Hanus, of the U.S.S. *Enterprise*, states that in November, 1890, when in the fairway of the Caribbean Sea, between lat. 14° 40′ N., long. 75° 28′ W., and lat. 13° 32′ N., long. 77° 4′ W., the current was found to run about 1¼ knot per hour, setting about W.N.W.; but, from this latter position the Westerly set was rapidly lost, and the next day a slight Easterly current was found, which gradually increased as the coast was approached near Colon.

(330.) Lieutenant A. H. Bisschop Greevelink, in command of the Dutch Royal Navy brig *Echo*, 1833—1837, from his four years experience in these seas, came to the following conclusions :—" The direction of Currents in the Atlantic is reconcileable with the force and direction of the Trade Winds, but the height of the water-level in the Caribbean Sea will sometimes baffle every calculation both within and without the range of islands, as shown indubitably by experiments founded, not only upon the method of ascertaining Currents at sea, but also within sight of land, and observations made on shore along the coasts. It has also been found that during calm weather, even with strong Easterly winds, the Currents have sometimes been running for days together to the Eastward, especially in the latter parts of January and July, when, by the then prevailing strong winds, the water is heaped up in a very uncommon degree, and the inner part of the Caribbean Sea, most probably overcharged, succeeds in re-establishing its equilibrium by forsaking the power of its wrathful driver. In this manner, I think, we ought to reconcile those circumstances mentioned (314) by the illustrious Spanish commander, Admiral Cosmé de Churruca.

" In the Caribbean Sea the force and direction of the Currents are more distinctly modified by the direction of the wind. With continual light winds and smooth water the Currents are generally weak, augmenting only in proportion to the increasing wind. This may serve as a proof that, among other less perceptible causes, under which they are governed here, Wind is the most powerful agent; for the indraught through the channels appears plainly to proceed from the force and extent of the Trade Winds. In this sea, from the Windward Islands Westward, to 72° of longitude, the general direction of Currents, observed during our four years cruize, was N.W. and Westerly; the weakest in October, November, April, and May; the strongest in December, January, February, and March, along the coast of Venezuela, and in July and August in the Northern parts; but, in general, so much always depended on the force of the wind, that, with few exceptions, *almost every voyage was affected by a force of current corresponding to that of the prevailing wind.*"

(331.) *From Trinidad, Westward*, and off the North side of the Leeward Isles, the Current has been found setting West and S.W. to the Gulf of Maracaybo; thence S.W. also to Cartagena. From *Cartagena* toward the *Channel of Yucatan* it has been found N.N.W., N.W., W.N.W., and N.W. by N., from 1 to nearly 2 miles, and then decreasing to 1½ mile per hour. On these coasts it has also been found setting to the *Eastward*, as shown in the following pages.

" On the *Colombian* (now Venezuelan) *Coast*," according to the *Derrotero de las Antillas*, " from Trinidad to Cape la Vela, the Westerly Current sweeps the frontier islands, inclining something to the South, according to the strait which it comes from, and running about 1½ mile an hour, with little difference. Between the islands and the coast, and particularly in the proximity of the latter, it has been remarked that the Current at times runs to the West, and at others to the East. From Cape la Vela the principal part of the Current runs W.N.W.; and, as it spreads, its velocity diminishes. There is, however, a branch, which runs with the velocity of about a mile an hour, directing itself toward the coast about Cartagena. From this point, and in the space of sea comprehended between lat. 14° and the coast (the Bay of Guatemala), it has, however, been observed, that in the dry season the current runs to the Westward, and in the season of the rains, to the Eastward.

"On the *Mosquito Shore*, and in the *Bay of Honduras*, no rule can be given for the alterations of the Current. All that can be said is, at a good distance from land, it has generally been found setting towards the N.W."

(332.) The Baron Alexander von Humboldt, in describing his passage from Cumana, Westward, to La Guayra, said:—"The general motion of the waters between the Tropics towards the West is felt strongly on the coast during two-thirds of the year only. In the months of September, October, and November, the Current often flows toward the *East*, for fifteen or twenty days in succession. Vessels on their way from La Guayra to Port Cabello have been known to be unable to stem the current that runs from West to East, although they had the wind astern. The cause of these anomalies is not yet discovered. The pilots think that they are the effect of some gales of wind from the N.W. in the Gulf of Mexico; yet these gales are much more violent in spring than in autumn. It is also remarkable, that the Current to the East precedes the change of the wind. It begins to be felt, at first, during a calm; and, after some days, the wind itself follows the Current, and becomes fixed in the West."—*Personal Narrative*, vol. iii, page 378.

(333.) Captain C. S. Cochrane, R.N., in his *Journal*, March 16th, 1823, says:—"In the afternoon we perceived high land through the haze, and hauled up for it, wishing to make a point about 50 miles to windward of Santa Marta; but on getting inshore, we found that we were 7 miles to *leeward* of that place, the Current from the Eastward having been running for the last twenty-four hours upward of 2 knots an hour; which agrees with Baron Humboldt's account, that the Current runs from 1½ to 2 knots an hour, according to the force of the wind and season of the year. The natives say, that the moon likewise has a considerable effect on this Current, which, at the changes of new and full, runs to the *Eastward* for twenty-four hours.

"Here I must caution all captains of ships navigating on this line of coast to allow for the Current, in general, at least 1½ knot per hour on an average, with an increase in proportion to the strength of the breeze, and an abatement at the new and full moons; otherwise, vessels heavily laden, overshooting their ports, may lose as much as three weeks by having to stand away nearly to the Antillas before they can get sufficiently to windward to gain the port they have missed; and even men-of-war run a risk of carrying away spars and masts in beating up."—*Vol.* i., page 52.

(334.) The following extracts from the Journals of Lieutenant Greevelink will be found of interest:—

"In January, 1834, the *Echo*, in crossing the Caribbean Sea, from Curaçao to windward, experienced a drift of 40 miles to the West, and escaped only by running straight for the coast of Hayti, beating to windward along that and the coast of Porto Rico, with the best success, and even assisted by weak Easterly currents when near the shore. The wind was from the E.N.E., sometimes blowing a gale; but, when sheltered by the land, the water was tolerably smooth.

"In December, 1836, the *Echo*, then on her passage from Surinam to Curaçao, with sharp breezes, found the Current sweeping through the channel between Tobago and Grenada; and, farther on, along the Leeward Islands, with a velocity of more than 2 miles an hour to the W. by N.; but, in October, 1836, on the same route, with light wind and calms, the water ran for days together to the Northward, at the rate of only half a mile an hour.

"In March, 1836, the same vessel, from Curaçao to La Guayra, with very strong winds, spent six days in beating up against a Current of 40 miles mean daily strength; and on April 8th left La Guayra for Porto Cabello, in the bight to the Westward, when, instead of making this passage in some hours, she had, during three days, to contend with light, variable, and even Westerly winds, and Currents to the N.E. 15 miles daily.

"The Baron von Humboldt's remark about the increase of the Currents near the Testigos proved true on our approach to the same islands, in December, 1835.* In the morning of the 12th, the longitude observed was 62° 45′ 15″, and the difference West in twenty-four hours appeared to be 32′ 15″; shortly after, the cluster of rocks came in sight; and at noon, at the very moment that the sun passed the meridian, the S.W. island, placed by Don J. F. Fidalgo in 63° 12′, bore East, distance 1 mile, having run by log 20 miles to the W. ¾ N.; so that, during these last four hours, the Westerly difference amounted to 8 miles, whereas, in former watches, it was only 5½ miles.

"A similar circumstance, we have reason to believe, also takes place at other groups of this range of sunken islands, and near such capes as are low and reaching far out, so as to obstruct the motion of the water beneath, and thereby redouble the force of the surface current, as denoted by the many instances of shipwreck and carcases of vessels (sad admonishers of precaution) spread among these flat, barren rocks, and produced solely by the irregularity of currents, which baffle every calculation, even those of the coast traders.

"But this variety in the Westerly Currents here is not the only cause of danger. The total change in the setting of the Currents from West to East is of a nature which requires the utmost care and attention, as they not only occasionally happen with calms, but also sometimes with fresh breezes from the Eastward. One of the first mentioned instances, particularly remarkable, we observed during our passage in October, from Surinam, through the Channel of Grenada, toward Curaçao. On the 7th and 8th, between the Island of Tobago and Cape Malapasqua, the water flowed to the *N. by E.* and *N. by W.*, with a trifling force; when suddenly, on the 9th, we had a difference of 17′ 54″ North, and 34′ *West*; and, on the following day, at the *new moon*, we were driven 11′ 12″ to the North, and 35′ 54″ to the *Eastward* of our supposed situation. This case was too singular not to excite our attention, as the high mountains of Caraccas showed us, almost hourly, the East or Westerly direction in which we were driven; the weather being perfectly calm, and the water constantly smooth, by which means we were able to verify our chronometrical observations, and to remove every doubt respecting the truth of so extraordinary a circumstance, the result whereof was as follows:—

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* The remark is as follows. The Baron, on approaching the Testigos, July 14th, 1799, says:—"During a calm, the Current drew us on rapidly toward the West. Its velocity was 3 miles an hour, and increased as we approached the meridian of the Testigos, a heap of rocks, which rise up amid the waters."

"By the Westerly Current we drifted in sight of the high land near *La Guayra*, and kept working up against the strong Easterly set the whole following day. On the 10th, from seven in the morning till four in the afternoon, we had 14 miles difference West, agreeing with the bearing of *Monte Avila*. From that time till six in the evening, when that mountain, of which we had lost sight for a moment by drifting to the Westward, again became visible, the water flowed again to the Eastward; and on the 11th, at six in the morning, with an observed latitude, and the said mountain bearing S.E. by S., we were in long. 67° 21′; and this by calculation being 67° 47′, we found a difference of 26 miles to the Eastward in sixteen hours. From this time till four in the afternoon, again 10 miles to the West; and from thence until the following morning, 22 miles Easterly difference. During the night we hove-to to the Southward of Caraccas Bay, Curaçao, and were obliged to keep *Little Curaçao* in mind, as the Current was setting strongly to the Eastward.

"Whether this flux and reflux were caused by the moon (then new), or by any other agent, I shall not attempt to determine. Indisputably there occasionally appear satisfactory reasons for ascribing to that luminary some influence over the Currents in these regions, and the above-mentioned case is probably one of them; but, as Captain Livingston says on the subject, 'the Winds have a still more powerful influence.' Indeed, when roving in these seas, studying the 'Memoir' and the 'Colombian Navigator,' and enjoying the pleasure of reading all that science and skill have ever produced in the description of these regions, we always meet with Captain Livingston's remarks as so many illustrations, and feel a continued increase of respect for so accomplished a navigator.

"The reflux of the Current to the Eastward, for some hours daily, we had also occasion to observe, in January, 1834, near the coast of Hayti, Porto Rico, and even in the Atlantic, while working up with smart breezes, and even with very strong winds; and once, in May, 1835, a merchant vessel, steering for Curaçao, with her mainmast broken, passed in the night to the Southward of Buen Ayre and Little Curaçao without seeing the land, being totally unacquainted with any existing Current, and consequently with her real situation. At daybreak, finding herself opposite the Eastern part of Curaçao, and supposing it to be the Island of Buen Ayre, she stood to the West for Curaçao, as she thought; but on her passing the Harbour of St. Anna she guessed her error, and tried to gain the entrance, in which she succeeded toward sunset, after hard struggling with a strong wind and a rough sea, but assisted by a Current to the *Eastward*.

"It should be borne in mind that the captain of this vessel was unprovided with a time-keeper, from want of which he knew nothing about

Easterly or Westerly Currents; and if, on his approaching Buen Ayre, he had accidentally stood a few miles to the N.W., so as to make its Northern coast, he would have found a watery grave, designated, perhaps, only by some piece of floating timber, a splinter, or broken spar.

"The uninterrupted Easterly Currents alluded to have already been mentioned by Baron A. von Humboldt; and, whenever I witnessed them, I found them just as described by that celebrated traveller. It may, however, be remarked that although this change in the general motion of the water is most common in the three months quoted, and chiefly along the Colombian coast, yet sometimes it also happens in other months, and in other parts of the Caribbean Sea; as we, in fact, once experienced it in December, once in April, near the coast above mentioned, and once in March, on our passage from Guadaloupe to Barbadoes, during which, vessels from St. Vincent's made their way toward the same islands in a few hours."

(335.) Observations taken in February, 1889, by the officers of the United States Survey steamer *Blake*, showed that South of Curaçao the current generally ran to the Westward on the surface, and to the Eastward underneath, but the under-current is of such volume that it is liable at times to entirely overcome the surface set.

(336.) In the *Bays of Guatemala* and *Honduras*, the Currents are frequently found to be running rapidly from *West to East*, especially near the shores. This counter-current is seldom encountered outside the lines which join their outer points. From Cape la Vela, or Northward of the Bay of Guatemala, the Current generally sets to the N.W. toward the Channel of Yucatan, as before remarked.

"In the space between Cape Gracias à Dios and Cape de la Vela, offshoots and eddies from the great Equatorial Current are found. This assertion is not merely grounded on those of former navigators, or on the examination of the coast outline, but on actual experience."—*Captain W. S. Smith*, R.N., H.M.S. *Larne*, 1833.

(337.) Mr. Town, in his "Directions for the Colombian Coast," has said:—"Although between the Island of Jamaica and the Spanish Main, Westerly Currents are most frequent, yet they do not always prevail; for ships have been known to be driven by the Current from 50 to 60 miles to the *Eastward* in four or five days. From the beginning of May till November (*the Rainy Season*), the sea-breeze seldom or never blows home to the Main; and ships going there should never go to the Southward of latitude 11° until they are at least 40 or 50 miles to the Westward of their intended port; after which they make a South course, as the land-breeze, which is generally from the S.W., and the strong *Easterly* Current, will set you to the Eastward of your intended port, if great care be not taken. When to the Eastward, if light winds prevail, you must stand to the Northward until you meet the sea-breeze, which will lie between the latitudes of 10° and 11°, and then run to the Westward.

"Being off Porto Bello, in H.M.S. *Salisbury*, on August 12th, 1816, and being a little to the Eastward of that port, with light variable winds for several days, the ship was set to the *Eastward*, at the rate of 30 miles per day; and, being afterwards placed in the same situation, I found it necessary to make the land well to the Westward, and to keep close to it. From November until May (the *Dry Season*) you should endeavour to make the land well to the Eastward, and run along shore; as the sea breezes generally blow very strongly, and the Current sets to the Westward at the rate of about 2 miles an hour.

Between Chagres and Porto Bello, during the rainy season, there is generally a Northerly Current, at the rate of 1½ to 2½ miles an hour. After the end of the rainy season the Current sets to the Southward and Westward, and strong Southerly and Easterly gales prevail here. From November until May (the *Dry Season*) the Southerly and Westerly are very light winds, except in squalls, which end with heavy rain.

"If at Chagres, at any time during the rainy season (May till November), and bound to the Eastward, endeavour to get 12 or 15 miles from the land as soon as you can; for the winds are, in general, very light, and the Current very strong. The latter sets from Chagres directly on the rocks of Porto Bello, and thence along the land E. by N., E.N.E., E.S.E., and according as the land lies; its general rate being from 1½ to 2½ miles an hour. Great care should be taken when near the land, if a heavy squall and rain appear to be coming on. During this you will have the wind from all points of the compass, and often so strong that all sail must be taken in.

"In crossing the *Gulf of Darien*, little or no Current will be found; wherever there is any, it sets about South, S. by W., or S. by E., up the Gulf.

"Near Cartagena the Current generally goes with the wind; but off the Islands of Rosarito it sets to the N.W. and N.N.W., from 1 to 2 miles an hour. Between Cartagena and the Magdalena, in the rainy season, you cannot put any dependence on the winds or current; but from November to May the Trade Wind blows home.

"I should recommend, if turning to windward, with strong Trade Winds, to keep the shore close-to; whereas, by going off from the land, you will not only have a heavy sea, but also a strong N.W. Current. If you have light variable winds, approach no nearer to the land than 12 or 15 miles, as you may be certain of an Easterly Current."

Captain Livingston says:—"During five weeks in which I remained at *Cartagena*, in June and July, 1817, the Current inshore set constantly and strongly to the Northward, at the rate, I am convinced, of not less than 1½ mile an hour, or nearly as strong as the Mississippi at New Orleans. I have seen the *Esk*, sloop of war, current-rode against a very fresh sea-breeze, when at anchor, nearly West from the city, distant about half a mile."

On July 31st, 1889, Captain Daniels, of the steamer *Caribbean*, between Cartagena and Colon, particularly off Farallon Sucio, observed the current to set E.N.E., 5 miles an hour!

Off Point Manzanillo, numerous tide-rips were observed from the U.S.S. *Enterprise*, in November, 1890, and a current of 1½ knot per hour setting to the Eastward. Captain James Lockwood, of the Pacific Mail Steamship Company, states that he has often found a current close in to the coast as strong as 2½ knots per hour.

As the land back of Manzanillo is high, and can be seen from 40 to 60 miles off, according to the state of the atmosphere, it forms a splendid landmark, and no allowance for the Easterly set is made by most of the captains of mail steamers, as, should the current happen to be slight, or no current at all be encountered, as sometimes happens, and allowance were made for the Easterly current, a vessel would make the low land to the Westward of Colon, where it is difficult to recognize. By making no allowance, a vessel is sure to make the high land of Manzanillo or that between Manzanillo and Colon.

(338.) Captain Lima, of the Pacific Mail steamship *Newport*, stated, in 1891, that in ninety voyages from New York to Aspinwall he always made Farallon Sucio, off Cape Manzanilla, bearing S. by W. to S. by W. ½ W., even in the rainy season, when no observations could be obtained. His invariable rule is to change his course, so as to allow for the *Easterly* set near this coast, as soon as he sights logs, trees, and driftwood. At his speed of 12 knots he allows one-half to three-quarters of a point, according to the quantity of driftwood encountered. If the quantity of driftwood is very great, and the discolorization of the water very marked, he sometimes allows as much as 1½ point. If he encounters no drift, he makes no allowance, and assumes that there is no current.—*United States Notice to Mariners, No. 9 of 1891.*

Some remarks on this Easterly set will also be found on pages 148—149.

(339.) In the *Bay of Honduras* there is no permanent current, but outside its limits it generally sets to the N.W. With respect to this, Captain W. J. Capes forwarded the following remarks to Mr. Purdy. He says :—

" Between *Jamaica* and *Bonacca* the Current generally sets to the Northward and Westward. Here, in May, 1816, I was set 60 miles to the Westward by the Current, and found that it set rather Northerly, from one-quarter to half a mile an hour. Between Jamaica and Bonacca are the islands called the *Swan Islands*. I would not advise any one bound to the Bay of Honduras to make these islands, for it cannot be of service, and the current is so very irregular about them ; and by falling in with them in a dark night, a ship would be in danger of running on shore, as the land is very low. About the *Southern Four Kays* the currents are very uncertain. I have known three ships to be lost on these kays by lying-to for the night, after they have made them ; for, at all times, the currents set strongly on them.

" If a ship be lying-to, under *Rattan*, it will not be amiss to try the Current. It is my opinion that the Current about Bonacca takes two different directions ; one part setting to the N.W., and the other part branching to the S.S.W. I have found it so on several trials, which is the reason that I prefer taking a departure (for the bay) from the middle or East end of Rattan ; for, if a ship take her departure from the West end, her course will be N.N.W. (1816) ; but it very frequently happens that ships get down on the reefs of the Southern Four Kays when they take their departure from the West end. The reason is this—a ship steering N.W. from the West end has more of the Current on her beam, which sweeps round the end of Rattan very strong at times ; consequently, ships that take their departure from the East or middle part do not feel so much of the Current."

(340.) *General Description of the Currents in the Bay of Guatemala, by Captain W. S. Smith, R.N.*—Captain Mackellar, R.N., a writer worthy of great respect, remarks:—"The Current between the island of Jamaica and the Spanish Main, or coast of Colombia, is not always to be depended upon as setting to the Westward, as is generally supposed; for, in crossing from Jamaica to the Main, ships have been known to be driven to the Eastward by the Current." This circumstance must be of rare occurrence at the Northern part of the passage, and is here mentioned to make known its possibility. I myself have made runs across between Jamaica and the opposite Main at many times and seasons, and am, therefore, governed by practice as well as theory in the following remarks.

1. *Local Current between the South side of Jamaica, the Morant Kays, and Pedro Shoals.*—This is very uncertain, both in rate and direction. Its rate may be from 0 to 1½ knot per hour; and its direction, either North, East, or West, according to circumstances. At the Morant Kays, the Current is known to be variable. Over Pedro Shoals it is supposed almost ever to run in a Westerly direction. Between these two dangers, therefore, it behoves a ship at night to be full of precaution, and not to rely on the continuance of any current she may have ascertained when either to the Northward or Southward of her then situation.

2. *Current Southward of the Morant Kays and Pedro Bank,* or between the parallels of 17° and 15°. This Current runs, perhaps always, true West to N.W. by W., from 20 to 55 miles per day.

Among the Mosquito Shoals the Currents are equally strong and more uncertain. Between latitude 15° and a line extending from Cape de la Vela to Cape Gracias à Dios, including some of the Mosquito Kays, the direction is W.S.W. to N.W., 20 to 40 miles per day.

3. *In the Bay of Guatemala,* Southward of a line between the Capes de la Vela and Gracias à Dios, and to the distance of 30 miles from the coast, the sets are so very variable as to baffle all system. Sometimes no current whatever is felt; at other periods it may run North, South, East, or West, 35 miles a day. Let it be borne in mind, however, that their direction is very seldom toward the *East,* but generally toward the *West.* St. Andrew's Isle and the frontier rocks of the Mosquito Bank are equally beset by changeable currents, of velocities amounting to *fifty* miles a day.

4. *Between Cape Manzanillo,* near Porto Bello, *and San Juan de Nicaragua, the Inshore or Land Current* sets from *Westward to Eastward.* It is an eddy, striking out from the Westerly Caribbean Current at Gracias à Dios, and eventually returning into it, with a broken and divided force, to the North of Cartagena. The breadth of this Current extends from the land to a distance of about 30 miles in the offing. Its rate is from 1 to 2 knots, and its direction parallel to the curvature of the coast and capes.

The streams out of numerous rivers, entering this Current, seem to inincrease its rapidity; for close inshore, between the rivers, the rate is seldom less than 2 knots; at 6 miles off the land it runs about 1 knot; and at a greater distance the same.

(341.) On January 9th, 1892, Captain Reynholds, of the barque *Hövding,* when in the vicinity of *Morant Kays,* states that his vessel was set out of her course 15 miles to the Northward by a strong Northerly current.

The United States directions say that the drift current, off Morant Kays, sets towards West and N.N.W., three-quarters of a knot an hour, after the Trade Wind has been blowing fresh for a day or two. When the Trade is lighter a current setting to the N.E. of East is frequently experienced. Vessels having occasion to pass near Morant Kays at night should keep Northward of them.

In March, 1889, the steamer *Blake*, when between Jamaica and Honduras, to the S.W. of *Pedro Bank*, found the surface current running to S.W. by W., gradually changing to the Westward to a depth of 130 fathoms, and tidal below that depth. Between Pedro Bank and Jamaica a tidal or eddy current was found, setting to the Eastward.

(342.) From *Cape Antonio*, the western extremity of Cuba, the Current sets, *at times*, to the E.S.E., past the Isle of Pines. Captain Livingston informed us that, in March, 1818, he found the current between the Great Cayman and Isle of Pines to set in that direction, at the rate of fully 2½ miles an hour, or 60 miles in the 24 hours. In August, 1817, he found the set nearly the same, but the Current not half so strong. The Spanish "Derrotero" says:—"From *Cape de Cruz*, on the South side of Cuba, it is noticed that there is a *constant Current to the Westward*, with some inclination to the Southward or Northward, and which has been known sometimes to set 20 miles in a single day." In opposition to this the exact words of Captain Livingston are—"I have twice experienced a strong Current, setting about E.S.E., between the Caymans and Isle of Pines; and on the latter of these occasions both my mate and myself separately calculated it to set about about 60 miles per day, or 2½ miles per hour. This, however, I incline to think is a very particular case, such as may but seldom occur. The winds at this time were light and Westerly. On the other occasion, so far as I recollect, it set about 12 or 14 miles per day only. All my papers on these subjects have been lost; but the first instance was too remarkable to be forgotten."

A further evidence of this is given by Captain Harry Miles, ship *Illustrious*. "December 29th, 1858, in rounding Cape Antonio, I could not detect any current. At times I have found it strong to S.E."

(343.) *Off the South side of Cuba*, between Cape Antonio and Cape Maysi, the current has frequently been found setting to the Eastward when the moon is increasing, or in her first two quarters. It is represented that it runs to the Eastward for a fortnight, and then to the Westward about the same time. Coasters from the Caymans commonly take advantage of the Easterly Current for making their passage to Jamaica.

From this information we may conjecture that the Current, which has been described as setting to the E.S.E. from Cape Antonio to Cape Maysi, is not *permanent*, but, at times, on the contrary, imperceptible, according to the age of the moon; and this has, we believe, been verified, in several instances, while the cause has remained unknown.

Captain Manderson stated, that when a strong Easterly wind has been blowing between Cuba and Florida, vessels heaving-to off the South side of Cape Antonio, at about 6 miles from the shore, have, in the course of one night, been carried against a strong sea breeze, nearly as high as Cape Corrientes, being a distance of 30 miles. Captain Rowland Bourke, once when lying-to in the *Archibald*, for the night, off Cape Antonio, also found himself, next morning, off Cape Corrientes.

Captain Monteath stated:—"In the months of May, 1814 and 1815 (two voyages in which I was chief mate of the ship *Prince Regent* from Kingston); in June, 1817, in the ship *Fame;* and in April and December, 1820, in the ship *Mary;* between Grand Cayman Island and Cape Antonio, I invariably found the current setting strong to the Eastward, or E.S.E.; and I have heard it generally remarked that vessels shaping a course from the Caymans for Cape Antonio have found themselves off, or even to the Eastward of, Cape Corrientes: this has, in the above cases, invariably happened to myself."

Captain Dunsterville has said, "I am firmly established in an opinion, from twelve years observation, that not only are the Winds and the Weather on the West India station influenced by the change of the moon, but the Currents also; and it is frequently found that, if the waters run to the Eastward, it is at the change and full of the moon."

On this subject Captain Livingston says, "It is a prevailing opinion with many, that the moon governs entirely the Currents among the West India Islands. No doubt the moon has some effect on them, but the Winds have a still more powerful influence.

"It is rarely, indeed, on the North side of the island of Jamaica that there is a Westerly Current when the North and N.W. winds prevail; the Current then always, or almost always, sets to the Eastward.

"On the South side of Cuba, when the wind is Westerly, which it often is, you are always certain of a reflowing current round Cape Antonio. This is easily accounted for; as when the fresh Trade Wind ceases, and the Westerly wind sets in, the barrier, which confined the waters in the Mexican Sea, is in some degree removed, and they seek to regain their level as well by the Channel of Yucatan as by the Strait of Florida."

Between the *Isle of Pines* and the main land of Cuba is a strong North-Easterly indraught, generally running from 1 to 1¼ mile an hour, and which has caused the loss of many vessels on St. Felipe Kays and the dangerous bank stretching therefrom to the Westward.

In the *Windward Channel of Jamaica,* the Current generally sets with the wind to leeward or S.W.; yet both here and at Jamaica it is variable. Some have affirmed that, when a Current runs to leeward on the South side of Jamaica, there is frequently one setting Eastward on the North side; and, at other times, no current is to be perceived; also that, when a lee current runs on the North shore, the same circumstances may be perceived on the South shore as were before observed on the North.

(344.) **Current Bottles.**—The following records, though old, of the drift of Bottles within the limits of the Caribbean Sea, will prove of interest:—

Caribbean Sea to Yucatan.—A Bottle from H.M.S. *Chanticleer*, in lat. 15° 29′, long. 76° 8′, to the Southward of Jamaica, at noon February 23rd, 1831, was picked up on April 20th following, upon the Eastern coast of Yucatan, after having traversed a distance of nearly 700 miles, at the rate of 28 miles per day.

Serranilla to Yucatan.—A Bottle from a boat belonging to H.M. surveying-ship *Thunder*, at anchor under Serranilla West Kay, March 10th, 1834, was picked up at Half-Moon Kay, in the Bay of Honduras, on the 23rd of the next month, April; rate 10 miles per day.

Tobago to the Cayman.—A Bottle from the American brig *Emma*, June 17th, 1838, in lat. 11° 4′, long. 58° 50′, was picked up on the 27th of the following August, upon the Eastern shore of the Grand Cayman; distance 2,000 miles, at the rate of 28·6 miles per day.

Windward Channel, between Jamaica and Hayti.—A Bottle from H.M.S. *Thunder*, in lat. 18° 56′, long. 74° 56′, April 7th, 1839; current then setting S.W. by S. half a knot; was picked up in the Grand Anse, near Jérémie (long. 74° 1′), on the 24th of the same month.

Hayti to Florida.—A Bottle, from the ship *Robert*, Captain Coulter, Eastward of Alta Vela, on the South coast of Hayti, was picked up about thirteen months afterward on the shore near St. Mary's, in Florida.

Some Bottles enumerated in Captain Becher's list: Ship *Racehorse*, Captain Home, thrown over in lat. 12° 12′, long. 65° 50′, April 17th, 1836; picked up April 22nd, at Bonaire, 150 miles in 5 days. Ship *Chanticleer*, Captain Austen, thrown over February 23rd, 1831, in lat. 15° 30′, long. 76°; picked up on the East coast of Yucatan, April 30th, 680 miles in 56 days. H.M.S. *Thunder*, Captain Barnett, thrown over at Chagres, April 22nd, 1840; reached Belize, October 1st, 1840. H.M.S. *Thunder*, March 10th, 1834, thrown over at Serranilla Bank; picked up near Belize, April 23rd; 575 miles in 44 days.

(345.) **The Channel of Yucatan**, connecting the Caribbean Sea with the Gulf of Mexico, is 105 miles in width, between Cape Antonio and Contoy Island, lying Eastward of Cape Catoche, the N.E. point of Yucatan. The Current most usually sets with considerable rapidity to the Northward through it, and according to the calculation of observations derived from Major Rennell, Commander Maury, &c., the following is the mean rate of the Current in the various months:—January, 33 miles per day; February, 34 miles per day; March, 36 miles; April, 33 miles; May, 17 miles; June, 26 miles; July, 29 miles; August, 31 miles; September, 30 miles; October, 38 miles; November, 36 miles; December, 48 miles per day. The annual mean of all these observations is 32·7 miles per day. These velocities are much inferior to what might be supposed from the magnitude of the outset of the Gulf Stream, as will be seen hereafter.

From the monthly results given in the Current Charts drawn up by the Meteorological Office, the annual mean is given as 33·9 miles per day. Mr. R. Strachan remarks:—The mean velocity of the Yucatan Current is 34 miles, but it flows into the Gulf of Mexico, towards N.W. by N., with a velocity of 41 miles; and at times the Current seems to be carried right across the Gulf. To the North and East there is no escape for it, owing to the Gulf Stream; hence the check felt in issuing from the Yucatan Channel bears it off to the Westward, but not until it has attained its maximum strength in about lat. 23° N., long. 86° W. There are times, probably, when the Yucatan Current is weaker than the Gulf Stream; then a counter-current, an overflow from the Gulf Stream, flows round Cape Antonio towards the Isle of Pines.

Captain Monteath stated as follows:—"In my passage from Kingston toward Campeché, in the ship *Fame*, June, 1817, between Cape Antonio and Cape Catoche, I found the current to set due *North*, 27 miles, in a run of eighteen hours."

(346.) The Currents in this channel were carefully observed by the officers of the United States Coast Survey steamer *Blake*, in March and April, 1887. We here give the results of these investigations, as detailed by Lieutenant J. E. Pillsbury, U.S.N.

It was found that the Northerly current did not fill the whole channel, and the surface currents on either side were variable in their direction. On the Eastern side of the channel, within 20 miles of Cape San Antonio, there was a light but persistent flow into the Caribbean Sea, its direction varying according to the declination of the moon. At the time of low declination its direction was between N.E. by N. and E.S.E., the mean being N.E. by E.; at high declination it was between East and S.E. by S., the mean E.S.E. The average velocity at 3½ fathoms was only from 0·50 to 0·75 knot per hour. At high declination an eddy current was found setting from off Cape Antonio along the Colorado Reefs, but at 30 miles off shore it set to the Northward and Eastward.

On the Western side of the channel, in 23 fathoms, 5 miles inside the 100-fathoms line of Yucatan Bank, the interference of the stream current with the tidal current was very noticeable; the flood tide running about N.W. for 18 hours, and on the ebb it ran to the Eastward.

In mid-channel the current varied but little from North, the average being N.E. by E. The axis, or part of greatest velocity, was found to be West of mid-channel, with a bodily movement to right and left, according to the moon's declination. The velocity averaged about 2 knots, the maximum (about 3 knots) being experienced 10 hours before the moon's transit.

The *Blake* was anchored at various distances between Cape San Antonio and Contoy Island, when the mean surface velocity of the Northerly current was as follows:—At 25 miles East of Contoy, 3·65 knots an hour; at 30 miles, 3·25 knots; at 35 miles, 2·37 knots; at 45 miles, 2·79 knots; at 60 miles, 1·56 knot; at 76 miles, 1·07 knot; and at 90 miles 0·51 knot.

At the first position, which is 5 miles off the 100-fathoms line of Yucatan Bank, an extreme daily variation in speed of 3·95 knots was found at high declination of the moon. It is stated in the "Annales Hydrographiques," 1889, page 236, that on one occasion it here attained a velocity of 6¼ knots an hour.

(347.) **Gulf of Mexico.**—The Mexican Sea appears to be the receptacle and terminus of all the waters flowing Westward. It was formerly considered that the Current through the Yucatan Channel diverging Eastward and Westward, the Western branch circulated around the whole of the Gulf to Westward and Northward, and thence flowing Eastward and South-Eastward, at rates varying from 14 to 31 miles per day, that it formed what was known as the "Great Whirlpool"* of the Mexican Gulf, and then joined the Eastern, and perhaps principal, branch of the Yucatan Current, forming the mighty Gulf Stream. Later investigations have shown that the general circulation of the water of the Gulf of Mexico is erratic in direction and feeble in force. Observations at twelve anchorages of the *Blake*, between the Mississippi Delta and Yucatan Bank, show a predominating direction to the Southward and Westward in the Northern half of the Gulf and close to Yucatan Bank, while between the two the flow is to the Eastward. The passage of water into the Straits of Florida is sometimes from the Gulf and sometimes from the Yucatan Passage; at high declination of the moon it is from the latter, and at low declination it is from the former.

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* See Dr. Lorimer, April 21, 1769, "Transactions of the American Philosophical Society, Philadelphia," vol. i., p. 250.

(348.) In Captain Maury's "Sailing Directions," 8th edition, vol. ii., p. 17, it is stated:—

There is a constant set from the Caribbean Sea into the Mexican Gulf to form the Gulf Stream, and vessels passing up to the Northward may take advantage of it. It is bifurcated just after entering the Gulf. The Bottle-paper of the *Hermes* followed this Yucatan Current to the "fork," and then took the Western branch.

"H.M.S. *Hermes*, April 15th, 1856, lat. 17° 59′ N., long. 78° 50′ W., H. Congton, commander, J. E. Solfleet, master. This Bottle, thrown over at the West end of Jamaica, was found on the South side of Padre Island, lat. 26° 5′ N., long. 97° 10′ W., August 23rd, 1857, and forwarded by Mr. J. R. Butler, who says, 'The drift shown by the course of this Bottle confirms my own observations since I have been here, viz., that the Current *divides* between Cape Antonio and Cape Catoche, the Eastern part rounding Cape Antonio, and passing out by the Gulf Stream, while the Western part keeps a Westerly course until it reaches the coast between San Fernandino on the coast of Mexico, and Corpus Christi on Texas, where it meets the South-Westerly Current from the coast of Florida and Louisiana. And it is strange to remark the mixture of floating objects thrown on the beach of this coast by the meeting of the Currents. Flat-boats, oars, saw-logs, clap-boards, old skiffs, &c., from the Mississippi, mixed up with branches of mangrove, mahogany, bay-cedar, young cocoa-nuts, canoe paddles of mahogany, &c., from the Caribbean Sea and Coast of Honduras.'

"It may be remarked on this that the Easterly winds may have someto do with the Westerly drift from the Mississippi of objects which float high out of the water.

"Another Bottle, from the ship *Admiral*, S. Picken, commander, thrown over on the Equator, long. 30° 45′ W., February 17th, 1856, came ashore at Aransas Pass, Texas, October 24th, 1856, 250 days afterwards, having drifted 4,300 miles, or 16 miles per day."

(349.) It is difficult to define the separation between the Currents which pass Eastward and Westward to the Northward of the Yucatan Channel. It is certain that they set with considerable velocity to the Southward and South-Eastward over the Tortugas Bank, and also to the S.E. from the Mississippi. Perhaps a line might be drawn from the centre of the strait to the mouth of the Mississippi, to the West of which it may be found that the streams have westing in them, and to the East of it that they set towards the Gulf of Florida.

(350.) Mr. R. Strachan, in his remarks upon the Meteorological Office Current Charts, 1872, says:—The waters of the Equatorial Current find a passage Westward and Northward round the Gulf of Mexico, and they keep up a well-defined movement of its water. Probably, in or about lat. 27° N., long. 90° W., a considerable portion of the Current which passed through the Yucatan Channel finds its way into the Gulf Stream. Hereabouts it would appear that the Currents are intricate, and difficult to ascertain by a day's run, from their conflicting influence upon the ship's course.

(351.) In the Supplement No. 2, 1891, to the Sailing Directions for the Caribbean Sea and Gulf of Mexico, published by the United States Hydrographic Office, it states, the Current coming up through the Yucatan Channel, takes a general North-Westerly direction, and then runs Northward to about the latitude of the Rio Grande. Thence it flows Easterly until off the Delta of the Mississippi, where it is diverted to the S.E., and continues on to the Straits of Florida. Off the mouth of the Rio Grande, and thence to Vera Cruz, anywhere within 100 miles from the land, a Southerly counter-current is usually found. When off the mouths of the Mississippi, within about 50 miles from the shore, a Westerly current is almost invariably encountered. This Current varies from 1 to 2 knots per hour, growing stronger as the land is neared, and must be allowed for by vessels approaching the passes. A strong, or long-continued Westerly wind, however, occasionally has the effect of neutralizing this current, and sometimes, though rarely, reverses it. A strong and long-continued Norther may have the effect of producing a general Southerly set all over the Gulf. In the centre of the Gulf there is seldom any current except in the case of a heavy Norther.

(352.) The following refers to the Currents on *Tortugas Bank.* Captain H. Miles, ship *Illustrious*, states:—"April 16th, 1859, at noon, in lat. 25° 36′ N., long. 83° 33′ W.; at 8 p.m. sounded in 38, 35, 33, and 32 fathoms, bottom at first depth coarse white sand, with broken shells, and gradually becoming of a greenish hue as the water shoaled. The wind being shy from S.W., I anxiously anticipated the Current which Blunt assures us 'runs lively to the Southward along the edge of Tortugas soundings,' in lieu of which, by a series of first-class observations, verified on making Bush Kay Light, I ascertained the set N.N.E., 1¼ mile per hour, since striking soundings. In fact, coupled with former experience, I am convinced that, although during the influence of Northerly and Easterly winds, a S.E. Current of considerable strength most certainly exists, yet with a Southerly breeze it is not only neutralized, but, as in the present instance, may set in a contrary direction, or to N.E."

(353.) The mean temperature of the water of the Gulf of Mexico is probably as high as any part of the Ocean, from several manifest causes, and hence it is, on the shores of this sea, that some of those nurseries of the Sargasso weed exist (292), which, torn from its habitat by the force of the current, &c., is drifted into that great central area of the Atlantic, to which it gives the characteristic peculiarity.

It is also probable that animal life is peculiar and abundant in these tepid waters. Lieutenant Evans remarks:—"The phosphorescent lights observed in the Mexican Sea shine with greater brilliancy (April) than I had noticed elsewhere; some of these were very large, and flashed like the priming of a gun, sometimes at a long distance from the ship. I observed that the little shining spiracles were confined to the sides of the vessel and her wake, and that the waves, when they broke into foam, did not (as in other parts of the ocean) sparkle.

"The colour of the water in the Sea of Mexico is of a dark indigo, darker or more intense than that of the ocean generally; the colour of the sea in the Florida Channel is a fine blue, not so dark as that of the Sea of Mexico, or of the ocean generally."

8. THE GULF STREAM.

(354.) The following description of the Gulf Stream is founded on a Paper by the late A. G. Findlay, F.R.G.S.,* with which we have incorporated much later information from various sources, but chiefly from the Reports of the United States Coast Survey.† There is much that is apparently contradictory in the observations of the various explorers, tending to show, that like most other terrestrial phenomena, this great Ocean Current is subject in its course to various vicissitudes, both in velocity and direction. The whole subject is fraught with many difficulties.

In the section on Passages to and from the West Indies, hereafter, are some remarks for the use of vessels being navigated within its influence, within and near the Strait of Florida.

(355.) The Florida or Gulf Stream has received more attention, has been the subject of more speculation, and has served as the basis of more theories than all the other Currents of the Ocean collectively. Although modern research, conducted with all refinement, in contradistinction to the imperfect observation of the passing seaman in former years, has shorn it of much of the grandeur and magnitude with which it was formerly invested, still it is a mighty and majestic Current, well worthy of all the laborious investigation which the philosopher and mariner have bestowed upon it.

The investigations carried out by the United States Government surveyors have dissipated all preconceived notions of its enormous magnitude; these were commenced in 1845, and when the first reports on the narrower portion, at the commencement of the stream, were published, subsequent to 1855, they were so startling as to be received almost with incredulity. But the subsequent most careful measurements of its Depth, Velocity, Temperature, and other collateral features, down to the present time, have tended to confirm, to some extent, the statement first made by Commander Craven in 1855, that the *narrowest* is the *shallowest* part of its course. From the numerous sections which have been examined, on lines transverse to its course, between the Caribbean Sea and the banks off Nantucket, we are enabled to calculate with some approach to exactness, what is the amount, velocity, and temperature of the volume of water which is transported by it into colder latitudes.

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* See Proceedings of the Royal Geographical Society, vol. xiii., 1869, pp. 102—112, "On the Gulf Stream," by A. G. Findlay; and the Journal of the Royal United Service Institution, vol. xiv., 1870.

† See the Annual Reports of the United States Coast and Geodetic Survey, especially that for 1890, Appendix 10 of which consists of a description of the Gulf Stream, by Lieutenant J. E. Pillsbury, U.S.N., being an account of his explorations during five years, when in command of the steamer *Blake*.

As these investigations have been made in the spring and summer months, the conclusions arrived at may be incorrect for the other seasons, though there are no good reasons for supposing such to be the case.

(356.) It may seem, therefore, somewhat surprising, that—in the face of its now known much smaller volume and much slower rate of travelling, and also of the well-ascertained interferences it has to encounter—a much more extended area should be claimed by some to be under its influence, than was considered to be when very much less was known of its real character. When Major Rennell's "Investigation" was published in 1832, containing a digest of all that was then known, the conclusion was arrived at, "that as a *Current*, it may be said to terminate at ordinary times at the Western side of the Azores;" and this is the sum of all the arguments subsequently used, with the exceptions that Dr. Franklin, in November, 1776, on approaching the European coast, was never apparently out of the warm water of the Gulf Stream; and that Colonel E. Sabine, in 1822, found an abnormal warmth of the ocean water in the Eastern part of the North Atlantic, which he attributed to the unusual strength of the Gulf Stream that season.

It was only after the acquisition of our comparatively *exact* knowledge of the Gulf Stream proper, between Florida and the Newfoundland Banks, that the argument was advanced—that it is the Gulf Stream, which, after traversing the intervening space of the North Atlantic Ocean, transports the amenity of climate over the whole of the North-Western shores of Europe; and also that in entering the Polar basin, past and around Spitzbergen, it keeps an open sea there, and by its warmth maintains a constant circulation around the North Pole.

(357.) It was during active researches in the Arctic regions, when the progress and fate of Sir John Franklin and Captain Crozier, with their ships' crews, were involved in such profound obscurity, that it was claimed for the Gulf Stream to have volume and power sufficient to have vast influence in ameliorating the Arctic climate. The failure of every attempt to penetrate the mystery, which had been so zealously directed towards the channels West of Baffin's Bay prior to 1851—1852, led Dr. Augustus Petermann to examine into the possibility of reaching the neighbourhood of Behring Strait by the way of Spitzbergen and Novaya Zemlia, and the elaborate and most useful investigations he then carried on led him to the conclusion that the varied phenomena he then elucidated, the abundance of animal life, the temperature of sea and climate, and certain features in almost every department of physics, could only be attributed to a warm North-Easterly Current, which he considered was an extension of the Gulf Stream.*

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* See Parliamentary Papers on the Arctic Expeditions; Further Correspondence, &c., 1852, pp. 142, et seq.; also Journal of the Royal Geographical Society, xxii., pp. 118—128, on the Distribution of Animal Life in the Arctic Regions, by A. Petermann, F.R.G.S.

(358.) To this last conclusion we still firmly demur, as in previous editions of this book, subsequent to the time when we were first made acquainted with the true dimensions of the Gulf Stream proper. In saying this, it must be distinctly understood that the effects claimed for it on the Eastern side of the Atlantic are not for a moment questioned. There can be no difference of opinion as to the *facts* which Dr. Petermann and many others bring forward in the elaborate memoir which he published.* It is rather a question of nomenclature, for the connection between these phenomena and the Gulf Stream proper is not shown.

The facts are incontrovertible, but it is strongly affirmed that these effects cannot be produced or effected by the Gulf Stream as now known, or by any fluctuations in its character. A very much wider field of action must be brought to bear on the subject; and it is contended that this North-Easterly drift or indraught, along the Scandinavian coast, should have a distinct name, as being an independent Current, having its origin somewhere between the coast of Europe and the Great Banks, and propelled Northward by the S.W. winds which prevail throughout the year on this part of the Atlantic, or by some greater cause. But in thus stating the case, it must be qualified in a degree by the fact that the Gulf Stream water forms a small part of this Current, but it is so cooled down and intermingled with the Arctic Current, that if any direct connection does exist, it is with both of these Currents, and that, perhaps, in an equal degree.

(359.) In the preceding Sections we have traced the course of the waters from the shores of Europe down to the great set or Tropical Drift, and thence through the Channel of Yucatan to the Western entrance of the narrow channel between the North shore of Cuba and the Florida Kays. Here may be said to be the commencement of the Gulf Stream as an independent Current, as it flows swiftly hence to the Eastward in opposition to its previous course, and then Northward through the Narrows between Cape Florida and the Bemini Isles. Keeping this direction with its high velocity and temperature, it is deflected to the N.E. by the form of the American coast; then assuming a more Easterly direction, and gradually spreading its warmer waters over a broader area, through an immense region of perpetual fogs rising from its tepid waters, it pursues its course with a gradually decreasing rate and temperature, until it reaches the Southern part of the Banks of Newfoundland. At this part it encounters the Arctic Current, which crosses its track and imports into it the influences of an Arctic temperature; owing to this, and the counteracting effects of an adverse current upon its diminished force and much decreased volume, it ceases to maintain its character as the Gulf Stream or an independent Current.

(360.) **History.**—The Gulf Stream was known by its present name, and in its now known form, from very early times. The Northern Equatorial Drift was noticed by Columbus, September 13th, 1492, when in lat. 27° N., long. 40° W., and this is the first Ocean Current observation. In his subsequent voyages, in 1502-3, he observed the strength of the streams in the Caribbean Sea.* The first voyage through the Gulf of Florida was that by Poncé de Leon, in 1512 or 1513, and this gave the first account of the Stream itself, and he named the present Cape Cañaveral *el Cabo de Corrientes*, from the circumstance. Several other Spanish voyagers, about this period, also experienced its effects, especially the pilot Antonio de Alaminos, who sailed through it in 1519. In Mr. Kohl's exhaustive and most interesting Monograph,† these and very many other earlier voyages are noticed, and the whole history of the subject dilated on.

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* Geographische Mittheilungen, Gotha, Justus Perthes, vol. xvi., 1870, parts 6 and 7. This most valuable essay, with ample references, was translated for the United States Hydrographic Office.

(361.) That excellent observer, William Dampier, in his "Discourses on the Trade Winds," &c., published in 1690, page 105, gives the following observations:—

"And 'tis as probable that the current, which sets to leeward on all the coast from *Cape St. Augustine* to *Cape Catoch*, never enters the *Bay of Mexico*, but bends still to the Northward, till 'tis checked by the *Florida* shore; and then wheels about to the East, till it comes nearer the Gulph's Mouth, and there joyning with the soaking current that draws down on the North sides of *Hispaniola* and *Cuba*, passes altogether with great strength through the Gulph of Florida, which is the most remarkable Gulph in the World for its Currents, because it always sets very strong to the North. Yet, near the shores on each side this Gulph there are tides, especially on the *Florida* shore; and Ships may pass which way they please, if they are acquainted.

"It has formerly been accounted very dangerous to meet with a North in this Gulph; and for that reason our *Jamaica* ships, to avoid them, have rather chosen to go to the Eastward and pass through the *Cacuses* (Caycos) in the season that Norths do blow. The *Cacuses* are sands that lie off the N.W. end of *Hispaniola*. Those that went from *Port Royal* in *Jamaica* had good reason for this; for if a North took them at their going out, it would help them forward in their way, which, should they have been going towards the Gulph, it would obstruct them. Then besides, if a North take a ship in the Gulph, the wind blowing against the Current makes an extraordinary Sea, and so thick come the Waves, one after another, that a ship can't possibly live in it, yet of late they go through at all times of the Year, and if a North takes them in the Gulph, they put away right before the Wind and Sea, with a small head sail; yet the Current is then as strong or stronger than at other times, and forces them back, stern foremost, against both Wind and Sea; for though the surface of the Sea is raised in Waves and driven violently with the Winds to the Southward, yet the Current underneath runs still to the Northward; neither is it any strange thing to see two different Currents at one place and time, the superficial Water running one way, and that underneath running quite contrary; for sometimes at an anchor I have seen the Cable carryed thus by two different Streams, the under part having been doubled one way, and the upper part the contrary."

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* He remarks:—"I hold it for certain that the waters of the sea move from East to West, and that in passing this tract (the Windward Islands) they hold a more rapid course, and have thus carried away large tracts of land, and that from hence has resulted the great number of islands." Recent observations do not seem to bear out this theory.

† Geschichte des Golfstroms und seiner Erforschung. J. G. Kohl. Bremen, 1868.

It is, therefore, somewhat surprising that a claim should have been made for Dr. Franklin as the real discoverer of its nature and its warmth in 1770. The tale is this:—Being in London in that year, he was consulted by the Treasury as to why the Falmouth packets were generally a fortnight longer to New York than common traders were from London to Providence, Rhode Island? He therefore consulted a Nantucket whaler, who laid its course on a chart, and explained that the Rhode Island captains, being acquainted with the Gulf Stream, avoided it, while the Falmouth commanders, being ignorant of it, were set back 60 or 70 (!!) miles a day by it. Without stopping to refute this altogether, which may be done by Dampier and his predecessors, it will be evident that something else than the Gulf Stream must have retarded them 60 or 70 miles a day in that latitude, if they were thus delayed.

(362.) **Causes.**—We have already given some general remarks (248, 249) on the origin and causes of surface currents. There have been very many speculations as to the cause of this great river in the Ocean, but they were promulgated before there was any increase of knowledge upon which to found arguments, and, as said before, recent investigations have overturned most of those which have been advanced. It has been supposed that it runs out of the Gulf of Mexico from the superior level of that sea, and facts are not wanting for such an assumption. Captain Manderson, R.N., gave an opinion in his "Examination as to the true course of the Florida Stream," that it was owing to the Mississippi and the floods from the other rivers falling into the Gulf of Mexico. It was still further argued that the velocity of the Gulf Stream might be determined by the floods from these rivers. But Captain Andrew Livingston, in our earlier editions, overturned this hypothesis by showing that what is poured into the sea by the River Mississippi is not a three-thousandth part of the volume of the Gulf Stream. He thought that it might be accounted for by the motion of the sun in the ecliptic, and its influence on the Atlantic waters.

The effect of *Temperature* is also advanced as the prime mover; increasing its heat, the water expands, and thus becomes higher than the cooler waters beyond it, and as the Gulf of Mexico has the highest temperature, here is the head water of the Gulf Stream on that account. Sir John Herschel says on this point:—"Let us see what this declivity, formed by unequal temperature, would amount to. The Equatorial surface-water has a temperature of 84° F.; at 7,200 feet the temperature is 39°, the level of which temperature rises to the surface in lat. 56°. Taking the dilatability of sea-water to be the same as fresh, a uniformly progressive increase of temperature from 39° to 84° would dilate a column of 7,200 feet by 10 feet (or 9·971 feet more exactly), to which height, therefore, above the spheroid of equilibrium (or above the sea level in 56°), the Equatorial surface is actually raised by this dilatation. An arc of 56° on the earth's surface measures 3,360 geographical miles, so that (were the water to run direct North) we have a slope of 1-28th part of an inch per mile for the water so raised to run down. As the accelerating force corresponding to such a slope (of 1-10th of a second, 0·1″ of arc), is less than one two-millionth part of gravity, we may dismiss this as a cause capable of creating only a very trifling surface drift, not worth considering, even were it the proper direction to form, by concentration, a current from East to West; *which it would not be, but the very reverse.*"[*]

With regard to this, Lieutenant Pillsbury, U.S.N., states that the temperature of the Ocean in the vicinity of the Equator reaches 37° F., at a depth of about 1,000 fathoms, below which the changes are slight to the bottom. The surface has a temperature not far from 80°. The expansion of the water due to this change in temperature is about ·005, which for the column of 1,000 fathoms would be about 30 feet, giving a grade from the Equator to the Poles of about ·06 inch to a mile, an infinitesimal difference.

Professor Ferrel considers that the effect of a difference of Temperature in the water of the Ocean between the Equatorial and Polar regions is similar to its effect on the atmosphere. The initial effect, before motion ensues, is to raise the surface of the Ocean at the Equator above that of the Polar regions (calculated by Mr. Croll to be 4½ feet), thus giving rise to a motion poleward, compensated by an under-flow from the Poles to the Equator. He also denies that the Winds are the origin of the Currents, and holds that they are primarily due to differences of Temperature, acted on by the effect of the earth's rotation.[†]

We may here draw attection to an ingenious theory advanced by General H. Mathiesen, of the Danish Army, founded on the study of special surface temperature charts. He combats the generally accepted idea of the circulation of the waters of the Ocean, holding that the surface isothermal lines (about which more will be said at the end of this work) indicate warm currents from the Equator towards the Poles, and cold currents from the Poles towards the Equator, the former being of a clear blue colour, and the latter discoloured by various organic substances. He argues that the Winds cannot be considered as the cause of the permanent Oceanic Currents.[‡]

Evaporation has been assumed as another cause, but it can be shown that the lines of maximum evaporation are near the Tropics, that is, near to the point from which the Gulf Stream removes and flows away, instead of running towards, if this be taken as a sole cause. But the line of greatest precipitation is near the Equator, and therefore the surface water of the Ocean is there lighter, or of less specific gravity, than under the evaporating Tropical influences; this source of instability will cause the waters to flow directly towards this line, throughout the whole circuit, and not in the form of a partial stream. Besides this, it is shown by the experiments of deep-sea exploring vessels, that the density of sea-water, at some fathoms below the surface, is very nearly the same all over the ocean (246), so that surface experiments afford but imperfect data, upon which little or nothing can be grounded in the present state of our knowledge.

(363.) There have been so many objections raised to the plain fact that the Trade and Anti-Trade Winds will account for many or most of the phenomena of oceanic circulation, that it would be far too discursive for a practical work like this to enter into such a field of speculation. All further theory must be sought for in those works which deal with speculative science. As stated in (2) page 98, the winds and water of the North Atlantic Ocean seem to follow much the same law, as far as their different natures will allow; that is, they circulate more or less around a central axis or area—the Calms of Cancer in the one case, and the Sargasso Sea in the other.

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[*] "Physical Geography," by Sir John F. W. Herschel, 1861.

[†] "Recent Advances in Meteorology," by William Ferrel, M.A., Ph. D., Washington, U.S., 1886.

[‡] "E'tude sur les Courants et sur la Température des Eaux de la Mer dans l'Océan Atlantique," par le Général H. Mathiesen; Christiania, 1892.

Captain Maury adduced arguments against the theory of assuming the Trade Winds as the prime cause of the Gulf Stream, in opposition to the line of reasoning followed by Sir John Herschel. He drew up several Tables to show that the S.E. Trades have a greater preponderating force over the N.E. Trades in the Atlantic, but he proceeds on the assumption of the *Equator being the division* between the two systems. This basis, which he elsewhere disproved, will very inadequately explain the relative force and duration of the two Trade Winds, as shown in (49), page 129. In fact, from arguing in this way, he endeavoured to prove, that from the much greater force (nearly twice) of the Southern Trades, from their much greater constancy, and still further, that from the greater preponderance of *Westerly* winds within the Tropics, on the North side of the Equator, *that the North-East Trade Wind scarcely blows at all in the North Atlantic Ocean*; a position which is disproved by his Pilot Charts, and by the experience of all sailors. The statement need scarcely be argued against, that the S.E. Trades have *quadruple* the force, and nearly *double* the duration of the N.E. Trades, making them *eight* times as important.

But besides this, the Wind and Current Charts demonstrate that the Northern edge of the S.E. Trades, and their consequent drift, are almost always felt throughout nearly the whole year, to the *North* of the Equator, and, in fact, send a large proportion of the water into the Caribbean Sea (13), page (102).

The Trade Winds may therefore be held to be a great cause of the Gulf Stream, and this opinion is strengthened by the results of the latest explorations made by the United States surveyors.*

(364.) From careful observations made in the steamer *Blake*, Lieutenant

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* "It is well known how easily a Current may be induced by the action of the Wind, and how a strong S.W., a N.W., or even a N.E. wind, on our own coasts, raises the tide to an extraordinary height in the English Channel, the River Thames, &c., as those winds respectively prevail. The late Mr. Smeaton ascertained, by experiment, that in a canal of 4 miles in length, the water was kept up 4 inches higher at one end than at the other, merely by the action of the wind along the canal. The Baltic is kept up 2 feet at least by a strong N.W. wind of any continuance; and the Caspian Sea is higher, by several feet, at either end, as a strong Northerly or Southerly wind prevails. It is likewise known, that a large piece of water, 10 miles broad, and generally only 3 feet deep, has, by a strong wind, had its waters driven to one side, and sustained so as to become 6 feet deep, while the windward side was laid dry. Therefore, as water pent up so that it cannot escape, acquires a higher level, so, in a place where it can escape, the same operation produces a current, and this current will extend to a greater or less distance, according to the force by which it is produced or kept up by the wind."—*Major Rennell, on the Thwart-Channel Current.*

Pillsbury, U.S.N., concludes that the Gulf Stream receives its water from the Atlantic, partly by means of the current driven by the force of the S.E. Trade Winds along the N.E. coast of South America, and partly by the current from the N.E. Trades. The water, as a *current*, flows through the passages between the Windward Islands, only, and not through the Anegada, Mona, or Windward Passages. Not all the water entering the Caribbean as described flows the length of that sea as a Current, but a portion of it returns to the Eastward through the passages, usually as an under-current. In addition, there is a large body of water thrown by the *waves* into the Caribbean Sea through all the passages. The Current found along the coast, between Trinidad and Curaçao, is chiefly produced by the escape of water thrown there by the waves, no large body permanently entering the sea through the passage South of Grenada. The flow of water across the Caribbean Sea is of the same character as that found outside the islands, a scarcely perceptible current on the surface at first, but increasing in its velocity farther West.

The water thus accumulated in the Western part of the Caribbean Sea escapes into the Gulf of Mexico, raising its surface level above that of the Atlantic. The reported difference of about 40 inches in level between the Gulf of Mexico, at Biloxi, and Sandy Hook, is probably largely in excess of the actual difference, though it is probably many inches. The evidence is that the small periodic changes of level of the Gulf of Mexico (0·3 to 0·41 foot) follow the changes in the Trade Winds, the highest level coming at the time when the winds are throwing the greatest amount of water into the Caribbean Sea, and also that the yearly variation in the Stream's velocity follows the change in the level of the Gulf.

Lieutenant Pillsbury continues :—" The average of all the Westerly flow between the islands, from St. Vincent to Antigua, gives a volume equal to about one-half that found in the narrowest part of the Straits of Florida. What, then, can account for the other half? I am convinced that it is the water thrown to leeward by the waves. Once in the Caribbean Sea, every wave formed gives the surface current an additional push by its momentum, so that by the time the part S.W. of Jamaica is reached, the flow has greater velocity than in any of the passages between the islands."

(365.) In previous pages, describing the Equatorial Currents, it was shown (302) to (317), pp. 343 to 352, that the united streams of the Northern Equatorial Drift and the much more powerful stream from the South Equatorial regions, when passing Cape San Roque and the Northern coast of Brasil, have a breadth of not less than 2,000 to 2,200 miles, and these flow with a velocity varying at times from 60 to 80 miles per day in the Southern part, to 10 or 15 miles in the Northern part of the drift. This Equatorial stream, which has a mean annual temperature of 77·6° (varying between 72·5° and 81·4°) on the Eastern or African side, and increasing to 80·6° (from 79·7° to 84·2°) on the American side, covers an area of not less than 5,400,000 square geographical miles of Tropically heated water. The whole of this moving surface impinges on the Eastern face of the Caribbee Islands, and here another difficulty awaits us. The line of islands diminish the water-way, the openings between Barbuda and Trinidad being in the aggregate not 230 miles in width, or less than one-half of the range. So that, theoretically, the stream should rush through the openings between the islands with redoubled velocity, but no such phenomenon occurs. The Currents here are constant, but not more violent than in the Ocean to the East. Moreover, it is shown on pages 358 to 368 (327) to (343), that the current has not sufficient power in the Caribbean Sea to maintain a persistent Westwardly course, but that it is liable to frequent interruptions, and is sometimes even reversed.

(366.) That part of the stream which fails to enter the passages is now considered to be deflected to the North-Westward, and to join the Gulf Stream after it has issued from the Straits of Florida. It is, however, but ill-defined and of small velocity, and from the evidence of floating bottles and other observations it has been considered that part of this drift forms a recurving current to the Southward and S.E., along the N.E. side of the Bahamas. So indefinite is this drift, that in the previous edition of this work it was stated that one half of this great drift therefore appears to die out on reaching the obstacle formed by the islands, and no clue has as yet been given to its extinction, but it shows one thing, that the movement must be very superficial, or it would be impossible for a great body of water to be thus quietly arrested.* The only outlet it appears to have is the comparatively puny Gulf Stream with a breadth of not more than one six-hundredth part of the parent source.

Lieutenant Pillsbury remarks that it seems evident there are two contributions to be found which tend to force the Stream onward, after it has left the Straits of Florida. One the current outside the islands, and the other the prevailing Westerly direction of the Anti-Trades. We have direct evidence of the flow outside the islands in the observations taken between Great Abaco Island and Cape Hatteras. At anchor about 60 miles from the Bahamas, the currents were all to the Northward and Westward, at the surface N.W., and at a depth of 200 fathoms N.W. by N. Midway between it was found that a slow movement reached to a great depth; the directions here were nearly all between N.N.E. and N.E. by E.

The meeting of the current outside the Bahamas with the Gulf Stream varies in position. We have no means of knowing the width of this outside stream, except by temperature observations, and these give over 200 miles. It is slower in movement, but of much higher temperature than the Gulf Stream.

We have previously given (325), pages 355—356, Sir Robert Schomburgk's remarks on this outer current.

Having thus endeavoured to trace the origin of the water of the Gulf Stream, we now proceed to give some account of its peculiarities in the various regions it traverses, premising, however, that in no sense can it be considered as constant, and it is fairly open to doubt whether Lieutenant Pillsbury, U.S.N., is to be considered as infallible when he affirms:—"That this wonderful Stream is governed by law in all its motions there can be no doubt. It has its daily and monthly variations in Velocity, Direction, and Temperature, changing with as perfect regularity as the tides in a harbour."

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* There is an exactly analogous case in the abrupt termination to the Guinea Current in the Bight of Biafra. It is traced up to the coast itself, and with a mean rate of 15 or 16 miles per day, and then disappears; it does not apparently unite with the South African Current setting to the Northward.

(367.) The Gulf Stream has had from the earliest times a very bad reputation among ship-masters for its dangerous character, and the hundreds of wrecks and millions of property which have bestrewed its margin have given good occasion for such a description. For not only is it to be dreaded for its stormy nature, but also for its violent stream, which renders a sailing vessel quite unmanageable during a calm. At these times, should hazy weather occur, and the sameness of the shores mislead the stranger, he is is open to many difficulties and dangers. But the excellent system of beaconage along the Florida Reefs, and the fine lights which direct by night, have very much reduced its bad character, and diminished the employment of that enterprising race, the wreckers of Kay West and the Florida Reefs.

(368.) **The Channel of the Gulf Stream.**—The peculiar and dangerous character of the shores of the Straits of Florida, and the necessity which existed for the establishment of some means of averting the mischief the Gulf Stream annually occasioned, led to a minute examination of its features so geologically and geographically interesting, which has been made practically useful by the erection of a fine line of beacons and the necessary lighthouses upon the Florida Reefs.

Professor Agassiz, who investigated this subject, has shown that the Florida Kays and Reefs are essentially of coral formation in various stages of existence. At Kay West, the basis of this is shown to be a coarse oolitic rock with cross stratifications, and dipping at various angles in different directions. The formation of coral upon this rock extends not only over the Kays, but also to the mainland of Florida, and by a careful process of inquiry and reasoning it may be inferred that a very different order of things existed at no very remote period of the world's history.

We have a peninsula—a narrow, flat strip of land, projecting for about 5 degrees from the mainland, between the Atlantic Ocean and the Gulf of Mexico, and forming an effective barrier between the waters of the two seas, which otherwise, even by the change of a few feet in the relative level of the intervening peninsula, would communicate freely with one another; and this peninsula we now know to have been added to the continent, step by step, in a Southerly direction.

We know that the time cannot be far behind us when the present reef, with its few kays, did not exist, and when the channel, therefore, was broader, and the Gulf Stream flowed directly along the main range of kays. We know, further, that at some earlier period the kays themselves were not yet formed, and that the channel between Cuba and Florida was wider still, washing freely over the grounds now known as the mud-flats, between the kays and the mainland, and that there was then nothing to impede a free communication between the Gulf of Mexico and the Atlantic Ocean.

If it is true that the Gulf Stream and the South-West winds have an influence in determining the course of the isothermal lines upon the two sides of the Atlantic, and of raising beyond their normal altitude the mean annual temperatures of North-West Europe, then we may look to the physical changes which have occurred on the South-Eastern extremity of the North American continent for the cause, or at least a partial cause, of those changes of temperature which have taken place in the beginning of the present period, in those very North-Western portions of Europe which are now so much warmer than the corresponding latitudes on the Eastern side of the American continent; and which, soon after the accumulation of the glacial drift, had as low a mean annual temperature as the coasts of Labrador, Nova Scotia, and New England in our day.

The present condition of the Florida country then is this:—On the outer edge we have the "*Reef*," a submerged line of danger to the navigator, which rises nearly to the surface of the water, on which every variety of coral life is developed. It follows the line of kays within it in a perfectly parallel curve, and forms the boundary to the Ship Channel inside it for hundreds of miles. Upon this line and space are small patches which rise above the surface, of course of dead coral, and upon these is gradually heaped the *débris* of the reef, in the form of sand and broken coral, till it attains a permanent level above the surface. Within this reef is a channel with depths of 2 to 7 and 8 fathoms, which, with care and some knowledge, may be navigated, and which has various openings to it through the reef.

These kays consist generally of coral boulders and the fragments of coral and shells heaped up by the action of the waves, and which have become agglutinated by some obscure process, till they become firm land, not by the upheaval of old coral growths, but by the action of a stormy sea and tremendous waves. They are generally level, and it is only at times that the water rises sufficiently to account for their elevation. On a later page is given an instance of an extraordinary rise in the waters.

In the year 1846, the water rose 8½ feet above high-water mark at Kay Vaccas. Kay West was entirely inundated during the same gale; and though it is somewhat protected by the reef, the rushes, driven upon it by the flood, might be seen among the trees and bushes, at a height almost equal to its loftiest summit. In 1841 the water rose 10 feet above high-water mark at Cape Romaine, on the Western shore of the peninsula.

Proceeding still farther Northward, we find an important result of the operation of the Gulf Stream, in the formation of the range of the Sea Islands of Georgia, so famous for the growth of its peculiar cotton. These low alluvial deposits are the results of gradual accretion still going on, and afford a genial soil for the cotton plant, while the tepid water of the Gulf Stream, which rushes past them, tempers the Easterly winds which blow on this seaboard, and add their important influences to the peculiar growth of this cotton plant.

(369.) **Characteristics.**—The *Indications of the Stream* are the *appearance* and the *temperature of the water*. In its lower latitudes and usual course, where it flows uninterrupted, it may be known in fair weather by its smooth and clear blue surface. Outside the line formed by a ripple on its edge, the water in some places appears like boiling water of a blue colour; and, in other places, it foams like the waters of a cataract, even in dead calms, and in deep water.

On the outer or S.E. edge of the Stream, especially in fair weather, there are great ripplings, which are very perceptible. The appearance of the sea-weed, by day, is an indication of this edge of the Stream; this weed being, *commonly*, on the outer edge of the Stream, in greater quantity and larger clusters than within it.

On its inner or N.W. edge the contrast between its clear blue water and the greenish coloured water of the cold Arctic Current is often very marked, besides the great difference in temperature of the two streams.

It has been stated by some observers that the water within the Stream does not sparkle in the night. That observant navigator, Captain Livingston, says that, though this is a common, it is a misconceived, idea :—" I have frequently seen it sparkle much; even last night it sparkled considerably, when we were in about 25° N., and 80° or 79° 40′ W.; and off Cape Roman, Cape Fear, Cape Hatteras, and the entrance of the Delaware, I have seen the water sparkle pretty much, though I think not equal to what it does in many other parts of the Ocean."—(*In the Stream*, September 10th, 1818.)

Mr. Ellicott said (Journal, 1803) :—" It has been mentioned by Dr. Franklin, that the water of the Gulf Stream *does not sparkle in the night.* This, so far as my observations go, is incorrect: I saw but little or no difference between that and the other water on the coast; but if there was any, that of the Gulf Stream was the most sparkling and luminous. It may, however, be observed, that the same water is very different, at different times, in this respect.

" The same ingenious writer and philosopher likewise observes, that the Gulf-weed is a sign of being in the Stream. This is in part true, but by no means to be considered as a general rule, because *the water on the borders of the Stream is constantly mixing with the adjoining water, and leaving some of the weed behind,* which consequently falls into the eddy currents, and is carried off many miles."

Lieutenant John Evans remarks :—Phosphorescent lights are equally abundant in the Florida Stream as in the Gulf of Mexico, some unusually large and brilliant; and some of the small lights appeared to spring out of the water with a sweeping motion, which I had never before observed; the temperature of the water was 79°, that of the air 76°.

(370.) **Extent.**—The Gulf Stream may be said to commence its great career between the Tortugas Bank and the Coast of Cuba, and the line joining the Dry Tortugas and Havana may be taken as its starting point. The channel is here 95 miles wide. Between Kay Sal Bank and Sombrero Kay the channel is only 54 miles wide; off Cape Florida, its narrowest and shallowest part, it is 44 miles in width; and between Jupiter Inlet and the N.W. part of Little Bahama Bank the channel is 47 miles wide. This confined part of the Gulf Stream, before it shoots off uncontrolled into the Atlantic, is 330 miles long.

Pursuing its way Northward, its warmest waters and strongest current keep near the edge of the bank of soundings which fronts the coasts of Georgia and the Carolinas, following the general curve very strictly, and in its main strength keeping 35 to 50 miles off Cape Hatteras, where the whole area occupied by the cold and warm bands may be included in a breadth of 150 miles. This portion of its course, from the channel within the Matanilla, is about 590 miles in length.

To the Northward of this, its N.W. edge still follows the edge of the bank of soundings, and being diverted more to the East by the obstacles lying off it, gradually winds more to the Eastward towards the parallel of 40°, to a line transverse to its course trending S.E. from Cape Cod, which will be about 480 miles beyond the Cape Hatteras section. It is here from 250 to 300 miles broad. Beyond this it pursues an Easterly course for 1,150 miles to the meridian of 40° W., which is 350 miles East of the Great Newfoundland Bank. After skirting the Southern edge of the Banks of Newfoundland, it proceeds with diminished velocity and temperature to about the meridian of 40° W. just named, when its farther drift to the Eastward cannot be distinguished from that of the whole surface of the Ocean to the North and South of it. The total distance we have thus gone over will be about 2,600 miles, throughout the whole of which its characteristics may be distinctly traced, although its lateral boundaries are not so easily defined.

It has been usual to extend its independent existence some 1,200 or 1,500 miles farther to the shores of Western Europe, as before stated, but when its volume in the outset, or in its *narrowest* part, is considered, it will be no great sacrifice of previously formed opinions to curtail it of its more extended features. Although thus deprived of a large portion of the magnitude with which it was formerly believed to be invested, it is not the less a wonderful stream, as it is able, so expanded and thinned out, to maintain its course and character unimpaired over the counter-currents of a totally different origin and nature which flow beneath it.

(371.) Throughout the latter part of its course its left-hand margin carries the greatest strength. In the Gulf of Florida its Southern side is the most powerful. Northward of the Gulf its Eastern and South-Eastern side is difficult to define, as it is found that the Gulf Stream may be said to consist of several longitudinal bands of water of different temperatures, as presently described. To the Southward of British North America its force gradually disappears till it is lost in the central still water of the Sargasso Sea.

The diagram of the Currents, which elucidates this section, will give a clearer idea of its relation to the great circulatory system, than any long description can do.

(372.) **Breadth.**—As stated above, it is difficult to define the exact boundaries of the Gulf Stream, especially its Southern side, where, owing to the accession of the warm drift outside the islands (366), temperature observations form no guide. Whilst the more minute examinations which have been made have added much to our knowledge of its features, they have not hitherto been sufficiently extensive to fix its limits, either by an average, or to give us the position of its margin in different seasons. However, as numerous observations have been given on its drifts, we may give a rude approximation to its extent from the positions where the drift has been found to be appreciable. In the narrowest part it is about 40 miles broad—a breadth it maintains to abreast Cape Cañaveral. Off Charleston it may be about 70 miles; off Cape Look-out, 100 miles; off Cape Hatteras, 150 miles; while off Nantucket, it has probably expanded to 300 miles, so that it has widened to more than seven times the breadth it commenced with.

With regard to its breadth off Cape Hatteras, Lieutenant Pillsbury, U.S.N., states from his observations, taken in May and June, 1887, 1889, and 1890, that the axis of the Stream was found about 10 miles outside the 100-fathoms line, or about 40 miles off the cape, the surface width being then practically the same as in the Narrows of Florida Strait. He considers that between Jupiter Inlet and Cape Hatteras, it is probable the average position of the strongest current will be found between 11 and 20 miles outside the 100-fathoms line. Off and beyond Cape Hatteras, it is, however, liable to more fluctuation in direction, particularly along its edges; and in its progress to the Eastward, by the time the Newfoundland Banks are reached, it is probable that these fluctuations entirely obliterate the Stream as a body distinguishable from its mate, which has come by the outside passage from the Trade region.

Lieutenant G. C. Hanus, of the U.S.S. *Enterprise*, which sailed from New York, October 30th, 1890, for Aspinwall (Colon), says they steered South from Scotland lightship, and entered the Gulf Stream in lat. 36° 30′ N., long. 73° 20′ W., about 125 miles North-Eastward of Cape Hatteras, the temperature of the water changing from 61° F. to 75° in one hour. The width of the Stream was found to be from 130 to 150 miles, as nearly as could be estimated. The time of leaving the Stream could not be determined by the temperature of the water on the S.E. edge, as the temperature changed but slightly, and gradually increased, with slight variations, as the vessel proceeded South. After leaving the Stream, a slight set to the Westward was encountered, which continued until the island of San Salvador was made.

That the Southern side of the Gulf Stream, to the Northward of Bermuda, is very ill-defined, will be best understood by studying the temperatures taken by H.M.S. *Challenger* in April and May, 1873 (see later on). It will be observed that the temperature was higher at Bermuda than at most stations to the Northward, both at the surface and below. Only in two observations between Bermuda and Halifax was the surface temperature found to exceed that at Bermuda, and then only by 1°. The direction of the currents in the passage between Halifax and Bermuda (May 20—28) also indicate that the Stream here was weak in power. As far as 37½° N. the current was observed to flow in a Southerly direction between S.W. and S.E., at rates varying from 10 to 26 miles in the 24 hours. In 37° N. the current flowed strong to the Eastward 32 miles. In 36½° N. only 7 miles N.E.; in 35° N. 7 miles E. by N.; and at 60 miles North of Bermuda a weak current of 3 miles flowed to the N.W. The wind in this passage, Southward of 40° N., was generally from the N.E., and varied in force from 3 to 7 Beaufort Scale (p. 104); between 40° N. and 36° N., Southward of this, it was very light.

(373.) **Depth.**—Deep-sea sounding is now conducted with such precision and certainty that any doubts which were formerly held on this topic must be abandoned. It is true that the labour and appliances can, in their extended use, only be at the command of Government vessels; but the United States Navy officers have done well to maintain their national honour in their endeavours to elucidate their famous Current.

Between the years 1845 and 1859, the United States Coast Department instituted a series of soundings and temperature observations along and across the course of the Stream, the operations being conducted in the *Corwin* by Lieutenants Craven and Maffit, and Commander Sands. Their observations in the Straits of Florida were so remarkable as to over-turn all preconceived notions of the great depth and volume of the Stream, though later investigation has shown that their work had need of revision.

The first reliable soundings of the bed of the Stream, from Florida Strait to George's Bank, were made by Commander Bartlett, U.S.N., in the *Blake*, in 1881 and 1882. Those previously made were with rope or registering devices, which in strong currents or great depths are unreliable. The latest soundings have been made with wire, by which the depth can in all cases be ascertained with certainty and accuracy.

The general plan of exploration of the Gulf Stream, laid down in 1845, was to observe the phenomena on sections perpendicular to its axis from well determined points on the coast. In pursuance of this design, numerous sections have since been run between the Western part of Florida Strait and the shoals off Nantucket, extending from the shore to beyond its outer limits. It is difficult to explain the nature of these soundings and their results without diagrams; but they are, of course, of more utility to the physical geographer than to the sailor. What follows on this head is mainly derived from the Annual Reports of the United States Coast and Geodetic Survey.

(374.) *In the Straits of Florida*, as in the bend of a river, it is found that the deepest water is along its concave or Southern and Western sides, as will be readily seen by reference to the chart, and here the Stream runs strongest. The following particulars of the more important sections are taken from the latest (1893) charts published by the United States Hydrographic Office.

Between Kay West and Havana, sounding operations were carried on under Professor Mitchell in 1866 and 1867, in connection with laying a telegraph cable. The distance between Sand Kay and Havana is 82½ miles, and the following are the depths shown upon the chart at distances of about 10 miles apart, going from N.N.E. to S.S.W.:—

136	369	508	862	936	924	968	472 fathoms.

It will be seen that the deepest water is on the Cuban side, over 900 fathoms being found within 7 miles of Havana. This characteristic is followed all the way along the Cuban side and that of the Great Banks. At Havana, as above shown, there is an abrupt descent of nearly a mile within 7 miles of the shore, while on the side of the Tortugas and Kay West the water is comparatively shallow and the descent gradual.

Of this breadth of 82 miles, the Gulf Stream was found not to occupy more than 40 miles on the Southern side of the channel, and Professor Mitchell was led to conclude that the Gulf Stream here has a nearly uniform velocity for a depth of 600 fathoms, although its temperature varies in this depth 40° F. At the surface it was from 81° to 82°; at a depth of 274 fathoms, 59°; at 492 fathoms, 45°; and at 555 fathoms, 42½°. This at once overturned all former speculations as to its enormous depth, and high temperature to all depths.

Besides the remarks hereafter given, a single fact will also suffice to show that the Gulf Stream does not fill this channel. Between 1857 and 1862 Captain E. B. Hunt, of the United States Engineers, was employed at Kay West, on the threshold of the Stream.* His careful observations fully bore out the elaborate geological survey by Professor Agassiz in 1850-51,† and demonstrate that these kays and reefs are slowly, but surely, extending to the *Westward* by the mechanical agency of a counter-current North of the Gulf Stream, in direct opposition to the strongest part of its course, which will be more fully dilated on hereafter. During bad weather, the sea about the reefs becomes milky, or "white water," from the bottom being stirred up by the waves. This white water is invariably drifted to the *Westward*, and the matter it carries is slowly deposited both North and South of the line of kays, and to 30 and 40 miles to the Southward of them.

(375.) *Between Sombrero Kay and Salt Kay Bank*, about 85 miles Eastward of the previous section, the Strait narrows to 54 miles, and the soundings across, at distances of about 10 miles apart, are as follow:—

112 239 370 500 385 fathoms.

The depth of 385 fathoms is found within 9 miles of North Elbow Kay, and it will be noticed how much the depth has decreased from the previous section, and that the descent from the Florida Reefs is much more gradual.

(376.) *Between Carysfort Reef and Orange Kay*, Great Bahama Bank, the channel is 60 miles in width, the soundings, about 10 miles apart, being as follow:—

118 365 475 465 435 200 fathoms.

The depth of 200 fathoms is found within 4 miles of Orange Kay, and the deepest water lies nearer the centre of the Strait.

(377.) *Across the Narrows* of the Straits of Florida, between Fowey Rocks and Gun Kay, the channel is 42 miles in width, and this is the most interesting section of the Stream, as careful observations taken within these comparatively narrow limits render calculations of the volume of the Stream to be within approximate limits of the truth. The earlier series of soundings made this to be also the shallowest part of its course, the greatest depth near the centre being stated to be 370 fathoms. Soundings taken at distances of about 5 miles apart from Cape Florida, are as follow:—

21 195 248 214 320 425 481 481 156 fathoms.

(378.) *Between Jupiter Inlet and Little Memory Rock*, Little Bahama

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* American Journal of Science, &c., vol. xxxv., pp. 197—210, and pp. 388—396.

† Professor L. Agassiz in the Report of the United States Coast Survey, 1851.

Bank, just before the Stream runs off uncontrolled into the Atlantic, the strait is 53 miles in width, and the soundings, at distances of about 5 miles apart, are as follow:—

20 95 176 250 341 416 439 395 347 294 100 fathoms.

The depth of 100 fathoms is found within 1 mile of Memory Rock, and it will be noticed that here, as elsewhere in the Straits, the Eastern side of the channel is the deeper.

(379.) The Stream emerges from the Straits over a bank which appears to have still shallower soundings than on the last section, and with reference to this, Commander Bartlett, U.S.N., makes the following remarks:—

"Instead of a deep channel which had previously been reported, our soundings show a nearly level plateau extending from a point to the Eastward of the Bahama Banks to Cape Hatteras. Off Cape Cañaveral it is nearly 200 miles wide, and gradually decreases in width to the Northward until reaching Hatteras, where a depth of more than 1,000 fathoms is found 30 miles off shore. This plateau has a general depth of 400 fathoms, suddenly dropping on its Eastern edge to 2,000 fathoms.

"The course of the Gulf Stream can almost be traced by the character of the bottom. On each side the sounding cylinder brought up ooze, but in the strength of the current the hard bottom was washed nearly bare, the specimens being small broken pieces of disintegrated coral rock."*

Northward of the Straits some curious variations of temperature are found in crossing the axis of the Stream, as will be presently explained.

Lieutenant Craven, U.S.N., was under the impression, from his series of soundings off Charleston and Cape Cañaveral, in the *Corwin*, in 1853, that the bed of the ocean was here of an undulating character, with two ranges of submarine hills at 96 and 136 miles off Charleston, and 1,800 and 1,500 feet high respectively. On the Cañaveral section the inner range was said to be 68 miles from the coast. As stated above, no trace of these submarine hills could be found when more perfect apparatus was used, but the bottom was found to be a plateau.

Lieutenant Craven noticed ripples on the Charleston section, thought to be in connexion with the irregularities of the bottom. Similar ripples were observed on the Sandy Hook section and on the Montauk section in 1845, and were compared to the "rips" on the Nantucket Shoals.

(380.) From Florida Strait, then, nearly as far as Cape Hatteras, the axis of the Gulf Stream has been found to run over a plateau with a general depth of 400 fathoms. To the Northward of this, the ocean is very deep. At 200 miles Eastward of Cape Hatteras the depth is 2,500 fathoms; at 150 miles Eastward of Cape Henlopen, 1,500 fathoms; at 180 miles E.S.E. of Nantucket, off the S.E. point of George Shoal, 1,350 fathoms; at 230 miles Eastward of Nantucket, off the Eastern edge of George Shoal, 1,340 fathoms; and at 180 miles Southward of Halifax, and 40 or 50 miles S.S.E. of Le Have Bank, 1,250 fathoms. Between this latter sounding and Bermuda the depths vary between 2,000 and 3,000 fathoms. These are depths to which the Gulf Stream has little or no influence, as shown by the Temperatures taken by H.M.S. *Challenger*, hereafter quoted.

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* United States Coast Survey Report, 1882, Appendix 11.

(381.) **Velocity.**—As would naturally be expected, from the difficulty of making accurate current observations from vessels in motion, there is great divergence between various observers as to the Velocity of the Gulf Stream. We consider it better, therefore, to repeat much that appeared on this subject in the previous editions of this work, and to give, in conclusion, the results recently obtained from the United States Coast Survey steamer *Blake*, when *at anchor* in various parts of the Stream's course.

Our knowledge of the velocity of the Gulf Stream is not sufficiently extensive to pronounce absolutely at what rate it flows as a mean for the whole year. It is very irregular in all parts, and there has been no systematic collection of observations recorded on the subject; those investigated show there are more variations than can be reconcilable with the change of the seasons. It is stated that the latter part of the month of August and beginning of September is the period in which it attains its greatest strength and highest temperature, and it is weakest and lowest in February, but fluctuates in all seasons according to circumstances. The strength of its Western and Northern borders, in its entire and vast extent, is much greater than those on the East and South, which have invariably a tendency to spread over the ocean in whirls or eddies, and are, therefore, comparatively weak.

Major Rennell estimated the Gulf Stream to move in the Narrows at from 82 to 96 and 120 miles per day. A more rigid calculation of his and other older data gives 65·4 miles per day as an annual average. This last estimate is much reduced by the investigation carried out by the Meteorological Office in 1872, which gives a mean annual rate of only 48 miles per day. The investigations carried out by the United States authorities appear to confirm the earlier figures.

(382.) Captain Livingston stated :—" The calculations of the velocity of the Gulf Stream are not to be depended on. I have found it setting at the rate of 5 knots, and even upwards; this was on the 16th and 17th of August, 1817. On the 19th and 20th of February, 1819, it seemed to be almost imperceptible. In September, 1819, it set at much about the rate described in the charts."

One remarkable instance of its diverging from the usually supposed velocity is given in a communication of Captain Giles, of the barque *Charles*, who found it to run 5 and 5½ knots, in January, 1843. " The first day I began to make any material progress was with the Tortugas bearing about S.E. ; the following day I had a current of 53 miles S.E. by S. ; the next day, 60 miles S.S.E. ½ E. I was then in lat. 24° 10′, long. 83° W. The weather would not permit our sighting the Tortugas, though we passed them very closely. The next day we made, by very good observations, 75 miles of due Easterly current, which, with the ship's work, placed her in lat. 24° 12′, long. 81° 33′ W. The succeeding day, towards dark, the wind being strong from E.S.E., and considering myself in the vicinity of the indraught of the Great Inlet, I put the ship's head to the Southward, under *close-reefed* topsails, and nothing more set, and reached her to till daylight, that being twelve hours good. Towards noon it fell calm; I then found that we had been set nearly in the direction that the elbow of the land trends *one hundred and ten miles*, we being at noon in lat. 25° 15′ N., long. 79° 45′ W. The following day we had light, variable airs and calms, heavy rain, much thunder and lightning, and very thick weather (as it had been the day previously). We picked ourselves up at noon, lat. 27° 20′ N., long. 79° 30′ W., having had the current N. by E. *one hundred and twenty miles*. I intended to pass through the Providence N.W. Channel, but the current swept us past the mouth of it in the light airs which we had on the last two days of our passage."

(383.) Captain (afterwards General) Sabine, F.R.S., said:—"There can be little hesitation in attributing the unusual extension of the Stream in particular years to its greater initial velocity.

"On the 5th of December, 1822, the *Pheasant*, bound to New York, quitted the Northern boundary of the Stream in lat. 36¼°, long. 72½°. In the Stream, in lat. 36° 14′, long. 72° 25′, the temperature of the surface water was 74°, and of the air, 65°. Between 10 a.m. and noon, the temperature had fallen from 74° to 62·4°, being a difference of 11·6°. The surface water on which the ship entered was in motion to the Westward, at the average rate of 16 miles in the following twenty-four hours, and generally to the West and S.W. between the Northern side of the Stream and the banks on the coast of Maryland. This motion may be more properly characterized as a *drift* current, occasioned by the prevalence and strength of recent Northerly gales, than as a *counter*-current. In approaching the bank of soundings, the surface water at 8 a.m. and at noon, on the 7th of December, was 59·5°; at 3 p.m. it had fallen to 54·2°; on which, upon sounding, bottom was found in 33 fathoms. On the following morning, in 30 fathoms, the surface was 53·5°, and at 8 a.m. on the 19th, in 12 fathoms, but still with no land in sight (being 20 miles off the coast), 41.5°. In the afternoon of the same day, when about 2 miles distant from Sandy Hook (New York Harbour), the water had finally lowered to 45°. Thus, in a space of the ocean scarcely exceeding 200 miles in direct distance, the heat of the surface progressively diminished from 74° to 45°."

(384.) From the work of the Meteorological Office, before quoted (239), we take the following general, and then the monthly observations on the Gulf Stream, as far as the parallel of 40° N., before mentioned.

The Gulf Stream, as far as the observations on these charts go, may be considered to commence near the Delta of the Mississippi. A Current setting N.E. by N., averaging 20 miles a day, in lat. 26° to 28° N., long. 95° to 90° W., appears to cross the 90th meridian, and unite with the Gulf Stream, which takes a direct course to the Florida Reefs, setting S.E., its rate increasing from 9 to 29 miles per day, in a distance of about 500 miles. On the right it has the Yucatan Current, which it forces Westward. At times, part of this S.E. Current finds its way round the West end of Cuba into the Caribbean Sea, as previously explained (345). On the left there appears to be an off-flow towards the E.N.E.; and North of the Florida Isles, about lat. 26° N., long. 83° W., the configuration of the land occasions a sort of eddy, and the currents experienced there are extremely variable in direction.

There being no outlet for the waters towards the N.E., and the Yucatan

Current confining it on the S.W., the main part of the stream is forced into the Straits of Florida, turning to the N.E. by E. in its passage between the Florida Reefs and Cuba at a mean rate of 39 miles. About lat. 25° N. the straits between Florida and the Bahama Banks become contracted, part being known as the Narrows. Here the set becomes almost due North, and its rate greater, averaging 48 miles. This rate and set is maintained to lat. 30° N. Thence to lat. 32° or 33° N., the direction of the set is N.E. by N., while the rate has decreased to 40 miles. Now the set changes to N.E., and is maintained to lat. 38° N., long. 70° W., the mean rate of the main stream being from 48 to 43 miles. The Stream is strongest towards the land side, being pressed upon by the Arctic Current, which probably causes the very high velocities sometimes experienced about lat. 36° to 38° N., long. 74° to 70° W.

On the right side the Stream is free to spread out, being only resisted by a feeble Westerly drift. Here accordingly we find the current weaker, even down to 10 to 20 miles a day. It must be remarked, however, that the observations made on the right edge of the Stream must frequently be in part due to the influence of the Westerly, or rather South-Westerly, drift, upon the ship's run in 24 hours, the final result depending on the preponderance of one or the other current during the interval. Whenever this has been suspected the observations have been separated from those believed to have been made entirely in the Gulf Stream, and averaged by themselves. In long. 70° W. the width of the Stream averages about 120 miles, extending from lat. 36° to 38° N. Thence its set becomes E.N.E., and its main portion seems to pass North of lat. 40° N., near long. 60° W. Between 70° and 60° W. the rate is from 37 to 27 miles per day. The Southern edge of the Stream can be traced to long. 45° W., about lat. 38° N., but the rate is feeble and the set variable.

In *January* the Gulf Stream may be traced from about long. 87° W. between lat. 25° and 30° N. Thence it flows to the S.E. and East between the Florida Reefs and Cuba, and is forced to the Northward by the Florida Channel, where its rate is 39 miles. Beyond this, observations are deficient, but they indicate the Stream as far as 37° N., 70° W.

In *February* it can be traced from the 85th meridian, between lat. 23° and 27° N., through the Gulf of Florida, Northward to lat. 32° N.; thence North-Eastward to lat. 37° N., in long. 72° W.; data are wanting beyond this. Its rate, North of Cuba, is 33 miles; through the Narrows, 53 miles; thence to lat. 32° N., 48 miles; beyond this, observations vary from 70 to 21 miles per day. A counter-current to the South-Westward is indicated from 35° to 30° N., which appears to become deflected to the E.S.E. by the Bahamas, but its force is inconsiderable, and it is probably variable in direction as well as in rate.

In *March* it seems to commence about lat. 28° N., long. 90° W., whence it flows S.E., rapidly increasing in velocity, passing around Florida at the mean rate of 40 miles, which it maintains up to 30° N. Farther Northward observations are not so numerous, and while they indicate a current to the N.E., and then E.N.E., up to lat. 37° N., long. 62° W., they assign to it extraordinary differences of rate. One observer vouches for a rate of 106 miles in 24 hours, about mean position 37° N., 72° W. From

30° to 35° N., the Stream is reported to be unusually weak in this month. There is evidence of a Southerly set between 27° and 30° N., Eastward of the Gulf Stream, as far as long. 70° W.

In *April* the Gulf Stream appears to commence at the mouth of the Mississippi, flowing South-Eastwardly towards Cuba, where it is turned Eastward, and then to the N.E. and North round Florida. Commencing with a rate of 22 miles, it becomes 36 miles off Cuba, and 48 miles off Florida, maintaining this rate to lat. 32° N. Its direction is now to the N.E., but its rate is undiminished to lat. 35° N. Beyond this, observations indicate the current to long. 58° W. in 38° N. It appears to extend from the coast to 65° W. on the parallel of 36° N. The counter-current to the S.W. is shown considerably farther Eastward than in the previous months, being to the East of the 70th meridian in lat. 31° N. Its rate is from 11 to 22 miles.

In *May* it may be considered to commence from the Delta of the Mississippi, with a rate of only 16 miles, but flowing S.S.E. it becomes 27 miles; then E.S.E. 35 miles; and passes between Florida Reefs and Cuba at the rate of 44 miles. Between Florida and the Bahamas it has the greatest mean strength yet noticed, 64 miles. Thence it continues North, N.N.E., N.E., and E.N.E., at a mean rate of 40 miles, until it reaches lat. 37° N., long. 70° W. Eastward there are indications of this current across the Atlantic, as far as the Azores, the rates given varying from 6 to 29 miles. On the whole, the Stream appears to be stronger, and to extend farther into the open ocean, than in April. There is evidence of a remarkable overflow from the Gulf Stream, setting E.S.E., at from 14 to 22 miles per day, between lat. 28° and 33° N., shown as far as 70° W.; also into the Santaren Channel, as if all the water could not pass with the main stream.

In *June* it may be considered to commence off the Mississippi at 12 miles per day. Thence it flows S.E. towards Cuba, at from 17 to 38 miles, then East between Florida Reefs and Cuba, at 50 miles. From lat. 25° to 30° N. there are no observations of it. From lat. 30° N. it flows North-Easterly to lat. 35° N., at from 46 to 63 miles. Between 35° and 40° N. it becomes more Easterly, and its rate is variously given from 14 to 48 miles. It can be traced to long. 45° W. in lat. 37° N. There is no evidence that it reaches the Azores. It has greater extension Southward between long. 55° and 70° W. than has been noted hitherto. There is no evidence of an overflow North of the Bahamas, although the Stream appears to be quite as strong as in May.

In *July* the Gulf Stream may still be traced from the Mississippi, flowing South-Easterly towards Cuba, at a rate of about 24 miles. Between Florida Reefs and Cuba it attains 51 miles, and from 25° to 30° N. it has been found to average 72 miles nearly due North. Thence it flows Eastward of North to lat. 36° N. in long. 70° W., at a rate of 30 to 43 miles. Its set is now Eastward, and can be traced to long. 35° W., but the observations are neither numerous nor consistent. On the whole it appears that the Gulf Stream is very strong this month, and that its Southern limit is in lat. 36° N., between long. 40° and 72° W.

In *August* the Gulf Stream, also, is not represented from its origin to lat. 35° N. From 35° to 40° N., and between 75° and 55° W., it appears to be strong, the rates varying from 12 to 56 miles. In the same latitudes, between long. 45° and 30° W., there is decided evidence of a Southerly set.

In *September* it is traceable from lat. 30° N., long. 80° W., at 72 miles a day, to 38° N., 63° W., at 31 miles. Between 60° and 70° W. it does not appear to extend farther South than about 37° N.

In *October* it passes through the Straits of Florida at 37 miles per day, but the observations are deficient in number.

In *November*, to the East of Florida, it has a rate of 70 to 53 miles; in lat. 34° N., it is 46 miles. Elsewhere there are no data.

In *December* the Gulf Stream is well shown from long. 87° to 67° W. In its South-Easterly flow to the West of Florida its rate is from 10 to 20 miles. East of Florida it flows due North, at from 50 to 54 miles. Thence to lat. 38° N., in its North-Easterly course, it maintains the rate of from 38 to 58 miles.

The *Arctic Current*, between the Gulf Stream and the coast, has been frequently experienced, its rate being from 10 to 15 miles. It may be the pressure of this cold water which causes the remarkable increase in the rapidity of the Stream about lat. 37° N.

(385.) *Action of the Wind.*—In the *Strait of Florida*, within the Bahamas, the wind probably retards or accelerates the Velocity. A N.E. gale in the Atlantic will probably bank up the water of the Stream, lowering its Velocity materially, and afterwards the flow will by reaction be greatly increased over the normal speed. There is no evidence of any change in the position of the axis due to the wind in the Strait.

Variations in atmospheric pressure in the Gulf of Mexico also cause a considerable retardation or acceleration of the current.

When a Northerly gale, increased to a storm, opposes the Stream in its course, this adverse power causes it to fill all the channels and openings amongst the Martyr Isles and Reefs, and to overflow all the low coast. Shipping have even been carried over the low kays, and left dry on shore. During these times, Florida Strait exhibits a scene beyond description.

In September, 1769, there was an inundation, which covered the tops of the highest trees on the Cayo Largo, &c., and during which the *Ledbury*, snow, John Lorain, master, was carried over the reef by the N.W. current of the Stream, caused by a gale from the N.E. The vessel bilged in shallow water, but an anchor was thrown out, and the next day she was found to have grounded on Elliot Kay, with the anchor among the trees. The water is supposed at times to have risen to the height of 30 feet, and to have been running against the fury of the winds at the rate of 7 miles an hour.

(386.) *Action of the Moon.*—Besides the effect which different winds have upon the Stream, it is subject to another power which also directs it toward or from the coast; and that is, the moon, which, according to her position, has different effects upon it, not, however, in equal power with those of the wind; but the disposition of the Stream is increased to its extreme, if the effect of both the wind and the moon are combined. For at this time, the ocean rising highest, this regulates the flood and ebb, and divides them in proportionate times; consequently it directs and increases them, with an Easterly moon and wind to the West, and with a Westerly moon and wind to the East; so that the West and East shores are at times deprived of, and at other times overflowed by, Tides, occasioned by these vicissitudes.

The boisterous East, N.E., and North winds, which affect the Gulf Stream, generally begin in September, and continue until March; when, if the moon happens just at the time to be on the full or change, they commonly end with a Hurricane.

(387.) The United States Coast Survey authorities, in order to render the investigations of their steamer *Blake* more reliable, decided in 1885 to make the attempt to anchor this schooner-rigged vessel of 218 tons register, along the axis of the Gulf Stream, and there make observations on its Velocity, Temperature, &c., at various depths. This was successfully accomplished, and much information added to our knowledge, a special form of current meter being used, devised by Lieutenant Pillsbury.*

Commander Bartlett, U.S.N., who was in charge of the *Blake*, between 1877—1880, before any attempt had been made to anchor in great depths, came to the conclusion that 3 knots an hour was a general average to allow for the whole Stream, but between the Bahamas and Florida, in the axis of the Stream, it was as high as 5·4 miles an hour.

Mr. Agassiz, who accompanied Commander Bartlett, states in his book, mentioned in the note on page 352, that the Gulf Stream flows at the rate of about one-fourth (*sic*) of a mile an hour through Yucatan Channel. Through the Straits of Bimini it has a velocity of 4 to 5 miles, but this velocity rapidly decreases as we go North. Off St. Augustine it is rarely more than 4 miles; from thence to New York it decreases to 2½ miles an hour; off the Banks of Newfoundland it is reduced to 1½ or 2 miles an hour; and at a distance of 300 miles to the Eastward the velocity of the Gulf Stream, which has constantly been spreading out fan-shaped, is scarcely perceptible.

General H. Mathiesen, in the work mentioned in the note on page 378, states that from his researches he considers the mean velocity of the Gulf Stream, throughout its course, to be about 58 miles a day, varying from 61 miles as a mean of January, February, and March, to 52·7 miles as a mean of July, August, and September,

(388.) **Lieutenant Pillsbury's Investigations.**—We have already mentioned, in the note on page 373, the valuable contribution to our knowledge of the Gulf Stream, drawn up by Lieutenant J. E. Pillsbury, U.S.N., and we now proceed to give information gained from its perusal.

During the spring and summer months of the years 1885—1889, the steamer *Blake* was employed in making observations on six sections across the Gulf Stream, as follow:—1. Cape San Antonio to Yucatan Bank. 2. Across the extreme Western part of Florida Strait, near the meridian of 84° W. 3. Rebecca Shoal to Havana. 4. Fowey Rocks to Gun Kay. 5. Jupiter Inlet to Memory Rock, Bahama Bank. 6. Cape Hatteras Shoals towards the S.E.

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* A wire half-inch rope was used for this pupose, the length of rope used varying with the bottom, current, and depth. In less than 600 fathoms two to three times the depth was required, and in 2,000 fathoms 3,000 fathoms of rope was generally sufficient. She could remain at anchor with the wind blowing at a force of 6 or more, unless with a heavy sea. The deepest water anchored in was 2,180 fathoms.

For those navigating the Gulf Stream, the most important questions to be answered are :—What is the surface Strength of the Current, and the Direction of the flow. It is well known that these vary at many if not at all parts of the Stream.

Section 4. Between Fowey Rocks and Gun Kay.—As the labours of two seasons, 1888 and 1889, were concentrated on this Section, the results are more complete than at the others, and in studying these results carefully we find the key to the solution of many of the apparent anomalies at points where there are fewer observations on which to base conclusions.

The whole width of the strait here is 43 miles, or 39 miles between the 100-fathoms lines. On the East side the bank is abrupt, 100 fathoms being found within 1 mile of Gun Kay; the current sometimes runs in as far as the depth of 10 fathoms, but generally it is farther off shore. On the West side the slope is more gradual, but the current is frequently found quite close to Fowey Rocks. The bottom varies, coral, clay, and mud being found.

The following Table gives the observations, which were only taken down to the depth of 130 fathoms :—

Anchorages, Miles East of Fowey Rocks.	Average Velocity in Miles per Hour.					Mean Surface Temperature.
	3½ fms.	15 fms.	30 fms.	65 fms.	130 fms.	
						° F.
8 in 205 fathoms.	2·661	2·346	2·252	1·590	0·634	80·24
11½ in 260 ,,	3·461	2·895	2·936	2·421	1·611	81·60
15 in 400 ,,	3.156	3·062	3.182	2·947	2·202	80·33
22 in 480 ,,	2·727	2·667	2·695	2·503	1·860	80·38
29 in 420 ,,	2·123	2·099	2·116	1·975	1·450	79·66
36 in 380 ,,	1·707	1·572	1·489	1·565	1·449	78·65

From the above it will be seen that the greatest surface velocity was found at 11½ miles East of Fowey Rocks, and this is its average position, but its flow is not at all times superior. The position of the maximum at different times during the month is intimately associated with the changes in the declination of the moon, and, indeed, not only the position, but the velocity and width of the whole Stream as well. In mid-channel the current appeared to flow to a depth of 325 fathoms.

Monthly Variation.—Following the changes in the declination of the moon, the velocity of the Stream at any given point in the Narrows is accelerated or diminished, but while it is running faster at one place, at another it is running slower. It is, in fact, a reduction in velocity at the sides accompanying an increase in velocity at the axis, and the reverse; or, in effect, an alternate expansion and contraction of the Stream in width. This is not marked on the East side of the Straits, but is very marked on the West side of the Stream.

It seems to be abundantly proved that the Monthly Variation in the Straits of Florida consists of an expansion at high declination, and a contraction with an increased localized speed at low declination. That at the time of the contraction there is a deepening of the current at its axis, and that at its expansion it has diminished in depth, but has increased its velocity on the sides. The most marked movement at high declination is an increased speed toward the left side, and but little towards the right side of the Stream.

The *Daily Variation* in velocity, also governed by the moon, sometimes amounts to 2½ knots, and is most marked on the surface, being far greater on the West side than on the East side of the Stream. It is greatest at the point of greatest average velocity. This difference in rate has taken place within 3 or 4 hours, as if a large wave travelled up the Stream, its front face being steep, and its rear less inclined. The change has been seen to be accompanied by a tide-rip when the wind was favourable for its formation, and within 5 minutes the speed of the current advanced over half a knot.

There are, in reality, two periods of increase and two of decrease during the lunar day, the first or highest maximum about 9 hours before the upper transit, and the lesser at 9 hours before the lower transit. Lieutenant Pillsbury thinks the popular belief that the axis of the Stream changes with the wind, is almost wholly due to the Daily Variation.

At the time of the monthly increase, the minimum current for the day follows the greatest maximum by about 6 hours. In the next 6 hours there is an increase in velocity equal to, or perhaps greater than, the preceding maximum. In the third interval there is a fall in speed, to be succeeded by a still greater maximum 9 hours before the next upper transit. At the time of the monthly decrease in velocity the conditions are reversed, the minimum preceding the maximum, and each succeeding maximum or minimum is less than the preceding. In the interval of change there is a short time of irregular velocities, when the maximum for the day arrives before the lower transit instead of the upper.

Section 1, between Cape San Antonio and Yucatan Bank, has been already described in (346), page 370, and the flow of the Equatorial Current from the Atlantic through the Caribbean Sea, on pages 358—368.

Section 2. Across the Western entrance of Florida Strait.—This section, 125 miles in extent, may be considered the real starting point of the Gulf Stream. Its currents vary greatly in direction, and owing to its great width the velocity is more feeble, and the characteristics which mark the other sections less pronounced. The eddy or counter-current, found on the North side (hereafter described), sometimes reaches this section.

Section 3. Between Rebecca Shoal and Havana the Straits are about 73 miles in width between the 100-fathoms lines. Being near the beginning of the Gulf Stream proper, the current does not fill the strait, but on its Northern side has a neutral zone of varying width, in which, at times, an eddy current sets to the Westward. The observations obtained here show that when the moon is near the Equator, the currents are more Easterly than Westerly, and when near the highest declination they are the reverse, although so weak that for the purposes of navigation they are not of much value.

Between Rebecca Shoal and Cuba the Currents have been long known to be extremely erratic. Vessels sometimes have an Easterly current along the Florida Banks, and sometimes a Westerly. Sometimes they set towards the banks, and at other times towards the middle of the strait. These variable currents are to be expected West of the Elbow, but the width of the variable zone is wider West of American Shoal than it is to the East. Vessels passing across the channel between Rebecca Shoal and Tortugas generally experience a Northerly or Southerly set.[*]

Section 4. Already described, pages 396—397.

Section 5. Between Jupiter Inlet and Memory Rock, the observations showed a change in velocity accompanying the changes in the moon's declination, as at section 4. At 3½ fathoms the temperature varied between 82° and 83·3°; at 30 fathoms, between 62·2° and 70·3°; and at 85 fathoms, between 60° and 63°.

Section 6. From Cape Hatteras Shoals towards the S.E.—Here the abnormal state of the weather rendered the observations unreliable, but the same dependence on the moon's declination was observed. The strength of the current, about 25 miles off Cape Hatteras and 5 miles outside the 100-fathoms line, was found on the surface, on two occasions running to the Northward and Eastward, and on the third to the South-Westward. At a depth of 200 fathoms the direction of the current was found to change regularly, as though tidal, running for about 7 hours S.E. by S. ½ S., and about 5 hours N.W. by N. ½ N.

Observations, taken in this position in the years 1887, 1888, and 1890, showed that at high declination the current ran strong to the N.E.; at mid-declination also to the N.E., but with much less volume; and at zero declination the set was S.W. The five other anchorages extended to a distance of 76 miles South-Eastward of Cape Hatteras. For about two-thirds of this distance the currents were found to be mostly to the Northward and Eastward at all depths, while at the two outer stations only the stratum below 65 fathoms was flowing steadily in that direction. Evidence of the movement of the axis of the Stream to right and left were also found in this section.

The following Table gives the particulars of the observations :—

Anchorage, Miles distant from Cape Hatteras.	Date.	Average Direction at the Surface.	Temperature in Degrees Fahrenheit.					
			3½ fms.	15 fms.	30 fms.	65 fms.	130 fms.	200 fms.
25	May, 1887.	N.E. ¾ E.	77·28	75·60	72·38	59·40	51·67	46·50
25	May, 1889.	N. by E. ½ E.	75·06	74·39	72·12	64·69	53·06	......
25	June, 1889.	S.W. by S.	80·19	76·19	69·13	58·13	49·56	44·75
30	May, 1889.	N.E. by N. ½ N.	79·80	79·50	79·00	73·20	......	......
47	May, 1887.	N.E. by E.	78·56	......	......	......	......	......
47	May, 1889.	E. by N.	77·90	75·79	74·38	70·94	64·50	62·63
52½	May, 1889.	Variable, N.E. by E.	74·48	73·90	71·64	67·21	64·28	......
65	May, 1889.	Variable, N.N.E.	74·82	73·20	71·38	70·83	65·06	61·11
76	May, 1889,	West.	77·50	76·70	74·85	70·81	64·50	62·20

The temperatures show how absolutely unreliable is the commonly accepted idea, that the warmer the water the stronger the current from the South.

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[*] Lieutenant Pillsbury, U.S.N., United States Coast Survey Report, 1887, page 174.

The following Table gives the position of the Axis of the Stream, where the greatest Velocity may be found, on the third day after the moon's highest and after zero declination.

Position of Axis.	At High Declination.	At Low Declination.	Mean.
East of Contoy Island.........	25 miles.	45 miles.	35 Miles.
North of Havana................	16 „	34 „	25 „
East of Fowey Rocks	7 „	15 „	11 „
East of Jupiter Lighthouse	15 „	23 „	19 „
S.E. of Cape Hatteras.........	31 „	......	......

Passing through the Straits of Florida, the axis of the Stream off Havana is nearest the Southern edge, but after making the bend between Salt Kay and Florida Reefs the axis is from 4½ to 11½ miles outside the 100-fathoms line on the West side. From Jupiter Inlet to Hatteras the average position of the axis is probably from 11 to 20 miles outside the 100-fathoms line.

The data obtained off Hatteras are not sufficient to decide positively how much the movement of the axis is. The width of the Stream at high declination is about 40 miles, reckoning from the 100-fathoms line, which is about the same width as in the narrowest parts of the Straits of Florida. It is probable that at high declination the position of the axis at Cape Hatteras is not more than 12 or 15 miles farther off shore than the mean position, but the conditions of the current outside the Stream at this point cause a slow surface-flow at times, which may lead to the belief that the Stream itself is very broad.

Daily Variation.—When the flow of the Stream is in the vicinity of the land, there is a marked daily variation in the velocity, caused by the elevation or depression due to the attraction of the moon and sun. There is a retardation of about 3 hours in the effect produced by this tidal influence. More exactly, the maximum Current near Tobago and St. Lucia occurs $6^h\ 10^m$ after the moon's transit; in the Yucatan Passage, about $2^h\ 26^m$; in the Straits of Florida, off Havana, $3^h\ 4^m$; off Cape Florida, $3^h\ 26^m$. In the open sea the daily variation is not marked.

In the vicinity of Barbadoes the time of high water is about 3 hours after the transit of the moon, giving a retardation of $3^h\ 10^m$ in the maximum flow. The maximum in the Straits of Florida is the reverse of that of the Equatorial Current, its arrival being $2^h\ 15^m$ after mean low water at the Southern Atlantic ports of the United States.

In the Straits of Florida, off Cape Florida, there is but one prominent maximum daily variation of velocity, usually arriving 9 hours before the upper transit of the moon. South of Rebecca Shoal Lighthouse, at a distance of 20 miles, the mean surface velocity is 0·30 knot, with a maximum daily variation of 0·62 (giving at times a Westerly current of 0·32 knot) and a mean daily variation of 0·49; at 35 miles, 0·74, 1·15, and 0·77; at 50 miles, 2·24, 0·65, and 0·62; at 68 miles, 2·23, 0·80, and

0·46; and at 86 miles, 0·77, 0·82, and 0·61. East of Fowey Rocks, at 8 miles, 2·66, 2·38, and 1·07; at 11½ miles, 3·46, 1·83, and 1·64; at 15 miles, 3·16, 1·67, and 0·92; at 22 miles, 2·73, 0·36, and ——; at 29 miles, 2·12, 0·58, and 0·42; at 36 miles, 1·71, 0·95, and 0·55. At the edges of the Stream in both cases, the surface directions of the currents incline toward the axis at times of low declination, but run nearly parallel to it at high declination.

Directions.—Lieutenant Pillsbury, in conclusion, gives the following directions:—A steamer bound from the Northward to Havana or the Gulf ports crosses the Stream off Cape Hatteras; a fair allowance to make in crossing it at right angles is 1¼ knot per hour, for a vessel's speed of 5 knots, for a distance of 40 miles from the 100-fathoms line. From the Southern edge of the Stream to Matanilla Shoal no allowance for current can be given. Upon sighting Bahama Bank, time will be saved by running down the Stream on the East side as far as Gun Kay, instead of crossing at Jupiter Inlet and running the latitude down on the Florida side. The current is weak on the Bahama side, though this route will be difficult by night until a lighthouse is built at Matanilla. From Gun Kay, an allowance for current of 2¼ knots an hour (the average velocity of the Stream) will make a course of West good to Fowey Rocks for a 5-knot vessel. The weakest current will be experienced about 3 hours before the transit of the moon. At high declination the strongest current will be found at 7 miles off Fowey Rocks lighthouse, while at low declination it will be found 4 or 5 miles farther Eastward.

A vessel running inside the Stream should keep inside the 100-fathoms line from Hatteras to Cañaveral, and then as close to the Florida shore as prudence will allow. Crossing the Stream at Havana, a fair allowance for the average current between the 100-fathoms lines is 1·1 knot per hour for a 5-knot vessel.

(389.) We here give the remarks by Captain W. C. Berry, on the navigation of the Gulf Stream, in continuation of those previously given on page 355. Bound from New York to New Orleans, he passed through Providence N.W. Channel. He says:—"The last three voyages, having reached the vicinity of the Little Isaacs in the day time, I have hauled in on the bank between Western Little Isaacs and East Brother Rock, and steered S.W. by W. by compass, which has brought me out in good passing distance from Moselle Shoal. During one of my summer passages out, after passing the above shoal, I was compelled to anchor, and remained there for six days. The wind during all this time was light from the Southward, and I could not help remarking the regularity of the Current setting along the Bemini Islands, ebb and flow, about 2 miles per hour. This continues as far as Gun Kay; when close in, little or no Current is experienced, except the ebb and flow, which is directly off the bank.

"In *Santaren Channel*, the Current is governed greatly by the winds; with strong Southerly winds the Current sets about N.N.W., 2 miles per hour; on the other hand, with strong Northerly winds, little or no Current is felt. After leaving Double-headed-Shot Kay, I have generally hauled over for Florida Reef, and in the day time kept close-in, when I have frequently found an eddy-current setting to the Westward from 1 to 1½ mile per hour. After passing the Tortugas, I have invariably felt a Southerly Current until I had reached the longitude of 84° 30′ W., and even further that this at times, particularly in November, 1848.

"Returning from New Orleans, I have always made it a point to keep to the Westward until I had reached longitude 85°, latitude 28°, before keeping off. My object in doing this is, that the Wind here generally prevails from the Northward and Eastward, and that the Current generally sets to the Southward and Eastward, which generally facilitates the passage. After rounding the Tortugas, with the wind from the Eastward, I have generally beat down on the Florida side, knowing that the strongest Current prevails on that shore, unless too close in. From Carysfort Reef to Matanilla, I have always endeavoured to keep in the middle of the Stream. During all my voyages, I have made it a rule to steer N. by W. from Matanilla to latitude 22°, and then North to latitude 31°, before hauling up N.E. by N.; by so doing I have, with a few exceptions, kept the strongest current. On some other occasions, I have hauled up on a N.E. by N. course, when in lat. 30°, long. 79° 40′, and have soon found myself on the Eastern edge of the Gulf Stream. After rounding Cape Hatteras, it is advisable to keep to the Westward, especially in the winter season, on account of the prevailing Westerly winds."

(390.) **Surface Temperature.**—The high temperature of the Gulf Stream is one of its chief characteristics, and has attracted from very early times almost as much attention as its velocity. Some remarks on this subject will be found in previous pages. A work, entitled "Thermometrical Navigation," written by Colonel Jonathan Williams, was published at Philadelphia, 1799, from which the following extracts are given. It will be seen, however, from what is stated later on, that the thermometer cannot be regarded as a completely reliable guide to its navigation.

Commodore Truxton says:—"In the Stream the water is much warmer than the air; indeed, I have known it 10° warmer; but as soon as you get within the Stream (that is, between it and the coast), the water becomes colder than the air; and the more as you get on soundings, and approach the shore. If mariners, who have not the opportunity of determining their longitude by celestial observations, will only *carry with them a good thermometer*, and try the temperature of the water, and compare it with that of the air every two hours, they may always know when they come into or go out of, the Gulf Stream. Indeed, I have always made a practice, when at sea, of comparing the temperature of the water and air daily, and often very frequently, during the day, throughout the voyage; whereby I immediately discovered anything of a current that was going, and afterward found its strength and direction by observations for the latitude and longitude. It is of the utmost consequence in making a passage to and from Europe to be acquainted with this Gulf Stream; as, by keeping in it, when bound Eastward, you shorten your voyage; and by avoiding it, when returning to the Westward, you facilitate it inconceivably; so much so, that I have frequently, when bound from Europe to America, spoke European ships, unacquainted with the strength and extent of it, off the Banks of Newfoundland, and been in port a very considerable time before them, by keeping out of the Stream; whereas they lengthened their passage by keeping in it.

"The general course of the Gulf Stream being marked on the chart, I would advise those who make the Northern passage from Europe never to come nearer the inner line of it, by choice, than 30 to 45 miles; and then the probability will be that their passage will be assisted by the help of a counter-current, which runs within it. In coming off a voyage from the Southward, be sure to steer N.W. when approaching the Stream, if the wind will permit you, and continue that course until you are within it, which may be easily known by the temperature of the water, as before mentioned. I have always considered it of the utmost consequence, when bound in, to cross the Stream as speedily as possible, lest I should be visited by calms or adverse winds, and driven far out of my way, which would prolong the voyage considerably, especially in the winter."

(391.) From the fact that when crossing the Gulf Stream from East to West, the temperature *suddenly* fell when its Western edge was passed, that is, coincidently with obtaining soundings, it was argued by Colonel Williams, and long maintained, that the thermometer would certainly indicate the approach to soundings by a fall in the temperature of the water, in any part of the ocean.

From the facts quoted, he infers that, "By the coincidence of these three journals, at so great a distance of time, and without any connection with each other, this important fact seems to be established:—*A navigator may discover his approach toward objects of danger, when he is at such a distance as to be able easily to avoid them, by attentively examining the temperature of the sea;* the water over banks and shoals, in these regions, being colder, in general, than that of the deep ocean."

Now although this remark holds good as to this portion of the American coast, and in some other parts of the world, under similar influences, yet it is founded on a fallacy, and certainly has not that universal application which former observers endeavoured to claim for it. This question is now generally well understood, and it is only necessary thus to refer to it, as a memorial of past times. When it was first promulgated, the extension of the Arctic Current to the Southward in such a remarkable manner inside the Gulf Stream was not suspected. And although Mr. Redfield's views, given hereafter, are now fully maintained, yet the more extended observations of the United States Coast Survey have revealed such singular facts, that even now we must confess our knowledge of the compensating system of the Ocean to be exceedingly imperfect.

His investigations in the *Blake* led Lieutenant Pillsbury to remark:—"I wish to particularly accentuate the fallacy of the idea, that the thermometer may be relied upon to indicate the presence of a current. I can see no way of utilizing it for the purposes of accurate navigation, nor indeed of using it to indicate with certainty that the current is favourable, or the reverse. The inner edge of the Stream is not necessarily marked by a change of temperature. An abrupt difference may be encountered at the true edge of the current, but the *cold* water may be moving N.E., or the *warm* water flowing S.W."

(392.) The *Mean Surface Temperature* of the Gulf Stream, in the early part of its course may be ascertained from the vast and confused mass of figures contained in Captain Maury's Thermal Charts. The temperatures thus recorded, however, show large variations between themselves in the same periods. This may arise from two causes—the one from the variation known to exist in the Stream itself, and which is frequently considerable; and the other from the imperfection of the thermometers used, and this, as many of the observations appear to have been derived from voyages made before standard thermometers were employed, may include a considerable portion of the discrepancies which exist. Another and very important addition to this branch of the subject, is the work of Lieutenant Andrau, "Onderzoekingen met den Zeethermometer," published by the Netherlands Royal Meteorological Institute, Utrecht, 1861.

The following are the results of the calculations for the temperature of the main strength of the Current from the Narrows of the Little Bahama Bank to the meridian of Halifax. To the Eastward of this, or of long. 60°, the temperature, especially in winter and spring, becomes rapidly lower and very irregular, as will be presently alluded to, and therefore our comparison will now be limited to this section, which comprises a distance of about 1,200 miles, and which is traversed by the Stream in from 25 to 35 days.

Winter.—Off Matanilla Reefs, 77·2°; off Charleston, 75·9°; off Cape Fear, 73·6°; off Cape Hatteras, 71·0°; off the Capes of Virginia, 71·0°; S.E. of New York, 70·5; S.E. of Nantucket, 67·9°; South of Halifax, 62·5°. It has thus cooled 14·7° F. in its passage.

Spring.—In Florida Strait, 77·5°; off Charleston, 76·5°; off Cape Fear, 74·7°; off Cape Hatteras, 72·0°; off the Capes of Virginia, 72·0°; S.E. of New York, 70·5; S.E. of Nantucket, 67·4°; South of Halifax, 63 5°. In the latter part of its course it is cooler in the spring than its ratio to the earlier part, owing to the higher velocity of the Arctic Current, which flows under and mixes with it.

Summer.—In Florida Strait, 83·2°; off Charleston, 82·4; off Cape Fear, 81·2°; off Cape Hatteras, 79·8°; off the Chesapeake, 79·8°; S.E. of New York, 79·2°; S.E. of Nantucket, 80·0°; South of Nova Scotia, 77·9°. Here the water preserves its heat without much diminution, being only 5·3° colder than when it leaves the Gulf.

Autumn.—In Florida Strait, 81·7°; off Charleston, 81·6°; off Cape Fear, 78·0°; off Cape Hatteras, 75·5°; off the Chesapeake, 75·5°; off New York, 73·0°; off Nantucket, 71·5°; South of Nova Scotia, 69·2°.

Upon comparing these temperatures, which are carried so many miles unimpaired by the Gulf Stream, with those of the inner Arctic Current between the Stream and the shores of Virginia, New Jersey, New York, &c., a surprising difference will be seen, especially in the spring months, when the difference is at a mean 30°, and in other seasons from 15° to 23°. This will be more fully entered into in the next section.

(393.) It has been found that the temperature of the Stream varies in a greater degree than could be accounted for by the climates it had passed through, being sometimes warmer to the North, and cooler to the South, of any particular position. This seems to be accounted for by the variability of the source of the Stream in the Gulf of Mexico and elsewhere, which it would be very difficult to follow up to any specific determination.

The temperature of the Caribbean Sea is above 80° F. from July to October; during the rest of the year it is below 80°, the minimum, about 75°, occurring in February and March. In the same latitudes, 10° to 20° N., off the African coast, the lowest temperature occurs in January, and the highest in July, when it rises to above 80°, as in the Caribbean Sea; but with this exception these Eastern waters are always from 3° to 7° colder than the Western. It will be noticed that the maximum and the minimum temperatures take place later in the year in the Caribbean Sea than off the African coast. This circumstance is probably due to the prevalent currents.

The Gulf Stream keeps the sea off the Southern States, from the Mississippi to Cape Hatteras, at a temperature above 80°, from June to October; above 70° during January, February, and March; and above 75° during the intervening months, April and May, November and December.

In striking contrast to this high and equable temperature of the seas off the Southern States, is the low and variable temperature of the seaboard of the Northern States, from lat. 40° to 36° N., due to the presence of the cold Arctic Current. Here in January, February, and March, the temperature of the sea falls below 50°; in April and May, and also in November and December, it is below 60°; in June and October it is below 70°; and in July, August, and September, it attains to 75°.

Months.	Sea Temperature in Lon. 74° W.		Change in 300 Miles.	Sea Temperature in Lon. 20° W.		Change in 1,800 Miles.
	Lat. 40° N.	Lat. 35° N.		Lat. 40° N.	Lat. 10° N.	
	°	°	°	°	°	°
January ...	49	68	19	60	70	10
February..	39	67	28	57	73	14
March......	45	70	25	58	78	20
April	50	70	20	57	78	21
May	54	77	23	58	76	18
June	62	79	17	62	80	18
July.........	69	82	13	66	76	10
August	72	78	6	70	80	10
September	65	78	13	71	81	10
October ...	62	75	13	69	82	13
November.	56	72	16	65	80	15
December.	50	71	21	60	80	20
Average ...	56	74	18	63	78	15

Where the warm waters of the Gulf Stream intermingle with, or flow side by side with, the cold Arctic Current, the changes in the temperature of the sea are large and sudden, and are noticed by all navigators of that region. If we contrast these extreme changes of temperature off the American coast with the slow change observed off the coast of Africa, the influence of Currents in modifying the temperature of the sea and determining climatic peculiarities becomes strikingly evident. With this view the above tabular statement has been compiled from the Charts, from which it appears that on the meridian of 74° W., the change of temperature from lat. 40° to 35° N., or in 300 miles, is on an average 18°; while on the meridian of 20° W., from lat. 40° to 10° N., a distance six times as great, the average change in the temperature of the sea is but 15°.

(394.) The investigations carried out by the United States Survey steamer *Blake*, have thrown some light on this subject. Commander Bartlett, U.S.N., who was in charge between 1877—1884, found that the average surface temperature in the axis of the Stream rarely exceeded 83° in June and July. On one or two occasions the thermometer read as high as 86°, and once 89° at high noon in a dead calm. The temperature at 5 fathoms did not range above the average of 81½°.

In 1881, in the Stream off Charleston, at a depth of 350 fathoms, the temperature was 50°, but in a hole of 500 fathoms it fell as low as 38°. The general average temperature of the bottom of the Stream was 45°.

In 1882, near Cape Hatteras, the temperature in deep water was found to be the same as in the Gulf of Mexico, but farther Northward, where the Stream spreads out, the depths of equal temperatures approached nearer the surface.

Lieutenant Pillsbury found that in the Narrows of Florida Strait the temperature of the Stream varied slightly according to the moon's declination. Here the highest average temperature is at the axis of the Stream, but there are times during the month when the sides are warmer than the axis was at some other recent time. Isolated observations are of but very little value, for at the same place the variations are great, even in an interval of a few days or perhaps hours. All that we can say positively is that cold surface water comes from either a polar direction or from a lower stratum, and the direction of its flow may be toward any point of the compass.

In the Atlantic, the inner edge of the Stream is not necessarily marked by a change of temperature. An abrupt difference may be met at the true edge of the current, and the cold water may be moving N.E. or the warm water may be flowing S.W. It is probable, however, that at about the time of high declination, warm water off Cape Hatteras indicates a N.E. current, and that at low declination the edge of the warm water has a set in the opposite direction.

In running lines of soundings from the coast as far as the 100-fathoms line, at intervals, from Cape Hatteras to beyond George's Bank, it has generally been noticed that in the vicinity of a depth from 40 to 80 fathoms, the temperature of the water suddenly changes, the colder being always found on the land side. The tidal impulse being about normal to the coast, and the Stream's course at right angles to it, Lieutenant Pillsbury believes that to this we may look for the cause of the lesser thermometrical variations, owing to the vibratory movement thus produced on the ocean's surface.

(395.) *Warm and Cold Bands.*—After leaving the Strait of Florida, the Gulf Stream was found, in the early operations of its investigation in 1845-48, to consist of a series of alternate bands of cold and warm water, a fact which was very surprising at the time, but the results of succeeding explorations to some extent confirmed the former ones in this respect. Between Cape Florida and New York the Stream was found to be divided into several bands of higher and lower temperatures, of which the axis was the warmest, the temperature falling rapidly inshore, and more slowly outside. This was not only the case at the surface, but, with modifications easily understood, at considerable depths, and must be owing to the meeting of the warm waters of the Stream with the cold water of the Arctic Current.

From observations taken under his direction, between 1854—1860, Professor Bache, Director of the United States Coast Survey, drew up a Table showing the relative distances off shore of these bands (three warm and four cold, varying from 25 to 75 miles in width, within 300 miles from Cape Hatteras) at ten sections between Cape Florida and Sandy Hook. He was led to believe they were caused by irregularities in the bed of the ocean, but by more improved methods of sounding it has since been shown that the bottom is not divided into hills and valleys along the United States Coast.

Later investigation with the steamer *Blake*, on some occasions, has shown an absence of these bands, and, in 1881, Commander Bartlett found no warm or cold bands till he came off Hatteras, and he considered that the work of the *Blake* seemed to show that the cold bands have no regularity, and only represent the unceasing conflict going on between layers of water of different velocities, and of different temperatures, as reported by Lieutenants Craven and Maffit, U.S.N., and dilated on in the previous edition of this work. In the seasons of 1883 and 1884, the temperature of the surface water was taken every mile on the twelve sections between Jupiter Inlet and Currituck, and in no case were any alternate warm and cold bands found, nor was any layer of cold water found at the bottom.

The earlier observations on the Hatteras, Cape Fear, and Charleston sections showed a *counter-current* where the cold streaks were found, but as stated in (391) Lieutenant Pillsbury clearly proved that from his observations the temperature of these warm and cold bands gave no clue as to the direction of their flow.

(396.) **The "Cold Wall."**—The separation between the warm, deep blue water of the Gulf Stream and the inner green water of the cold Arctic Counter-Current is sometimes so well marked, that "one end of a ship is seen in the one, and the other end in the other current."* Although it does not follow that this line of demarcation is so distinct as Captain Maury says, as above, yet a remarkable feature has been elucidated by the United States Coast Survey, so often quoted here. It is, that between the coast and the Gulf Stream there is a fall in temperature so abrupt that it has aptly been called the "Cold Wall;" this extends, with varying dimensions and changes of its peculiar features, along the coast from Cape Florida, Northward, as far as examined. Professor Bache stated that inside this "Wall" was another band of water of increased temperature, whilst outside the warmest band, which is next the "Cold Wall," was another warm and one other cold band.

This "Cold Wall," from later investigations, cannot be considered as permanent, as on some sections its absence was in some years conspicuous. Lieutenant Pillsbury says:—"I am convinced that the so-called "Cold Wall" is not the inner edge of the Stream, but is near the dividing line between the Stream proper and the outside Atlantic current, and that the maximum velocity will always be found some miles Northward of it. The current outside the Stream is not comparable with the latter in point of velocity; its speed probably is never much over 1 knot, and usually much less."

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* H.M.S. *Nile* is reported to have once found a surface temperature of 46° F. at her bow, while it was 70° at her stern.

(397.) The earlier surveyors were of opinion that the "Cold Wall" appeared at the line separating the Gulf Stream from the Arctic Current, their observations showing the separation between the two currents to be so well marked beneath the surface, and to the greatest depths, as to have obtained for it the title of the "Cold Wall," being, in fact, an upright division between them. This peculiarity was found to exist almost along the whole coast of the United States, where the Stream skirts the bank of soundings. Without diagrams the features cannot be made quite intelligible; but the main fact, so interesting to the physical geographer, is as above stated—that there appears to be a marked non-affinity between the waters of the two currents.

It was at first supposed the "Cold Wall" was cut off at Cape Hatteras, but subsequent researches have qualified this notion. The cold water has been traced as far as the Tortugas. Off Sombrero Kay, in some of the earlier researches, the "Cold Wall" was strongly marked at depths varying from 70 to 100 fathoms, while everywhere the warm water overflowed the "Cold Wall," and reached quite to the shore.

(398.) *Subsurface Temperatures.*—It was formerly held that the Gulf Stream flowed on in one majestic current of warm water from its surface to its bed. The magnitude of its effects, and the extent of the area attributed to it, seemed to leave room for no other conclusion. But the first observation of ice-cold water at a small depth, in its narrowest and strongest part, followed by the discovery of the parallel warm and cold bands, overturned all these hypotheses, and left philosophers in a most perplexed condition to know where to look for an explanation.* How this cold water, flowing directly contrary to the course of the upper strata, should preserve its Polar characteristic almost unimpaired to such an enormous distance from its origin, and under such apparently adverse circumstances, could not then be explained. Again, by what power, or source of action, are the lower strata made to move in an opposite direction to those superincumbent upon them, and which, it might be supposed, would be acted on by the same laws and move in the same manner?

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* In the earlier experiments made by the United States Coast Survey, the temperature was gained at all depths, from the surface down to 600 fathoms. At great depths a peculiar thermometer was used, constructed for the purpose, whose principle of action depended on the differing expansion of two metals. It is a spiral coil, composed of two strips of silver and platinum soldered together, which, from their unequal contraction and expansion by the effects of temperature, act on an index, which registers the extreme temperatures.

But later experiments have shown that many of these results are fallacious, both as respects this differential evil, and especially with the ordinary thermometer with unprotected bulb as formerly used; and, therefore, all of them will require revision, as the probability, nay certainty, is that the recorded temperatures at great depths have been placed much too high. Of this more hereafter. The more recent investigations have been carried on with the Miller-Casella Thermometer and with Siemens' Electrical Thermometer.

The accuracy with which deep-sea sounding is now carried on has afforded a clue to this mystery. There seems to be a slow movement of the cold waters on the bed of the Ocean from the Arctic and Antarctic regions towards the Equator, forming one of the most remarkable evidences of that grand compensating system by which the Great Creator has ordained that all the harmonies of the universe shall be maintained—which keeps the atmosphere and ocean in a perpetual condition of interchange, and thus makes them fit for the sustenance of his creatures.

We have alluded to this universal intermingling of the ocean waters before (246). Of the presence of Polar water in these Tropical regions there can be no doubt. The following extracts from one of the earlier Reports of the United States Coast Survey* will place it beyond question:—

"The Southern sections present, on a small scale, the same phenomena which we formerly traced over a large expanse in the more Northern ones. Examining the Cañaveral section, which is the farthest South, we see the Cold Wall almost as plainly as on that from Sandy Hook; the curve, showing the mean results between 70 and 100 fathoms, rises some 17° from 57½° to 74½° F., in the distance of 23 nautical miles. The warm water, overlying the cold, is deeper in its overflow towards the shore—that is all. Passing the warmest water, there is a fall of temperature of several degrees, followed by a rise. On the St. Simon's section, the Cold Wall is again well shown, and is the first of those distinct bands of minimum temperature dividing four maxima, of which the greatest body of warm water of the Gulf Stream is the second from the shore. Near the surface the first and fourth maxima are the highest; at 15 fathoms, the first and second; at 150 fathoms, the successive maxima rise as they recede from the shore. The Charleston section presents, as a general feature, between 25 fathoms and 250 fathoms, four minima and three maxima. Within the Cold Wall minimum is a decided *warm* belt, and probably farther on inshore is a cold one. The rise in the mean of the temperature, at 20 and 30 fathoms, is 11° F., namely from 64° to 75°. The advantage of not relying on surface temperatures, or those near the surface, where the distribution is so much less regular and marked than below, will be recognized in all these results, and was early provided for in my instructions.

"The underlying cold water from the Northern regions is as plain in the Southern section as it was in the more Northern. At 400 fathoms vertically below the warmest water of the Gulf Stream, on the Cape Henlopen section, in August, 1846, the temperature was 49° F., and in the same position off Cape Cañaveral, in June, 1853, it was 48½°.† The latitude corresponding to the first temperature was about 37° 20′, and to the last about 28° 20′. Lieutenant Charles H. Davis, in October, 1845, found a temperature of 40° at 1,000 fathoms, in lat. 39° 25′, long. 69° 1′, and Lieutenant George M. Bache 40° at 2,160 fathoms, in lat. 34° 13′, long. 68° 5′. Lieutenant S. P. Lee, in August, 1847, found 37° below the Gulf Stream, at the depth of 1,000 fathoms, in lat. 35° 26′, long. 73° 12′; and again 48° beyond the Gulf Stream, at the same depth, in lat. 30° 10′, long. 68° 9′. Lieutenant Richard Bache, in July, 1848, found a temperature of 42° at 1,000 fathoms, in lat. 35° 6′, long. 74° 7′, below the surface of the Gulf Stream.

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* Professor A. D. Bache, United States Coast Survey Report, 1853, pp. 48—49.

† Reference may be again made to the note on the previous page relating to these deep sea temperatures. The comparisons with more recent observations show that these temperatures are too high by 2° or 3° at 500 fathoms, and perhaps as much as 6° or 10° at 2,000 fathoms. This is owing to the great pressure of the water on the *unprotected* bulb of the thermometer forcing up the mercury.

"The fact that the side limits of the Polar Current recede from the shore as the depth increases, is clearly marked on all the sections. Directly down below the maximum surface temperature, we soon plunge into this cold current, the warmer water receding from the shore, and at 400 fathoms reach temperatures, the differences between which, at the North and South, are of an order corresponding to the variations of the ocean waters in different years and at different seasons. For example, at the depth of 400 fathoms, on the Sandy Hook section, in 1846, vertically below the crest of the Gulf Stream the temperature was 51° F.; on the Henlopen section, at the corresponding point, 51°; on the Cape Henry section, 54½°; in 1848, on the Cape Henry section, 52½°; and on the Hatteras section, 52°; in 1853, on the Hatteras section, 51°; and on the Cape Fear section, 54°; all the foregoing observations being made in July and August of the several years. In June, 1853, the temperature at the point and depth before noted on the Charleston section, was 55°, and near Cape Florida, 14 miles E.N.E. from the light, was 51°, varying from 54° to 46° in the intermediate localities. The low temperature of 46° was observed on the Cañaveral section. The temperature at 400 fathoms, near Cape Florida, is the same as observed on the Sandy Hook section in July, 1846, viz., 49°.

"I remarked that these differences came within the annual changes near the surface. Not to complicate the examination with surface irregularities, if we compare the maximum temperatures at 12 or 15 fathoms below the surface of the different sections, in the same year, we shall find, as a general rule, an increase of temperature in passing Southward, as 81°, 83°, 82°, from the Sandy Hook to the Cape Henry section; in 1846, 75½°, 76°, 77½°, 79½°, from the Charleston section to that of Cape Cañaveral. But in successive years we have for the highest temperature at 12 fathoms, on the Cape Henry section, higher than that of Hatteras; and the temperature in July, 1846, on the axis of the Gulf Stream, higher at Sandy Hook than in June, 1853, at Cañaveral, by 1½°, and higher than Charleston by 5½°. It is obvious that here an interesting field of enquiry opens, requiring careful research."

(399.) **Counter-Currents.**—Besides the great Arctic Current which flows Southward inside the Gulf Stream, and to be described in the next Section, there are some other counter-currents on each side of the Stream which require notice here. They appear in the first part of its course in the Gulf of Florida, where they have been known to flow from the earliest times, and alluded to in (374), page 388.

(400.) *The Counter-Current along the Florida Reefs* is marked on all the old surveys of these reefs, and is, during the summer months especially, frequently met with. It may be readily accounted for. On page 387 (374) it will be seen that the main strength of the Gulf Stream runs past the coast of Cuba, and that the channel is by much the deepest close to the South side, and slopes more gradually from the North. On the shallower water, but not within the reefs, this counter-current runs, by which a vessel may with ease and knowledge work to the Westward. It may be taken as an eddy, aided by the Trade Wind, which may give it an additional impetus. It was well elucidated by Lieutenant E. B. Hunt, U.S. Engineers, who, having stayed in the neighbourhood for some time, obtained some particulars from the well-informed residents of these Kays.*

(401.) Captain Geiger, who for some thirty years observed the waters of this vicinity, most of that time having acted as a pilot off Kay West Harbour, and who was, perhaps, better acquainted than any other person with the Currents there prevailing, gave the following statement of facts :—

A strong North or N.E. wind keeps the Gulf Stream back, and makes a Westerly current near the shore. During June, July, and August, the Westerly current prevails more than the Easterly current from 5 to 15 miles from the reef. The direction of the current depends mostly on the wind. The Westerly current prevails from one-third to two-fifths the entire time from year to year, for 2 to 15 miles outside the reef off the West. He had known it 25 to 30 miles off Sand Kay.

When the Gulf Stream is strongest on the Cuba shore, the Westerly current is strongest on the North side; and when it is weakest along the Cuba shore, the Gulf Stream sets close along the reef. He had found the Westerly current as far up as Carysfort Reef, but not frequently, and not broad or strong. The current broadens from Carysfort Reef to the Westward, and continues about constant along its course.

The Tides on the two sides of the reef are about six hours apart on an average, but set, on the whole, as much one way as the other over the reef. Sometimes there is a narrow *Easterly* current for a mile from the reef, then a Westerly current, and then the Gulf Stream. A considerable number of the Gulf traders know of, and make use of, this current in going Westward. After Northers, the Westerly current may be expected. Sometimes in crossing to Havana no Gulf Stream indications are found, and sometimes a Westerly current is found along the North shore of Cuba.

Notwithstanding Captain Geiger's long observation of these Currents, he was quite unable to reduce them to rule, or in any way to know beforehand how the current will be found to set.

Captain Richardson, pilot, of the United States Coast Survey steamer *Corwen*, says:—"The Westerly current appears irregularly, chiefly in winter, but sometimes during the prevalence of the regular Trades. It extends from 10 to 15 miles off from Sand Kay, and runs sometimes 2 miles per hour. It never prevails over the reef proper. It spreads farther from the reef as it goes West. Off Indian Kay it sometimes extends 7 miles from the edge of the reef; at Bahia Honda, sometimes 10 miles; and at Sand Kay, from 10 to 15 miles. Some years (as in the winter of 1856-7) there was very little of this current. The Gulf Stream usually runs stronger on the Cuban side. In one case, in 1852, two vessels bound East passed the Tortugas, and separated about 100 miles in twenty-four hours, one captain knowing this current and the channel, while the other kept in the Westerly or counter-current. The tide below the Quicksands and Tortugas sets flood N.N.E., and ebb S.S.E., differing from the Charts."

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* Silliman's American Journal, vol. xxvii., pp. 207—214. See also the remarks on page 388, relating to the "White Water" of the Tortugas.

Lieutenant Pillsbury, U.S.N., remarks on this counter-current as follows:—"Along the Florida Reefs the neutral zone which borders the Northern edge of the Stream probably begins in the vicinity of 'The Elbow,' near Carysfort Reef, and gradually widens until off Rebecca Shoal, where it extends from 15 to 20 miles outside the 100-fathoms line. It is narrowest at high declination of the moon, at which time it probably begins at some point to the Westward of 'The Elbow.' The direction of the current in this zone is ordinarily tidal in its character, but it is easily overcome by an abnormal current caused by difference in atmospheric pressure within and without the Gulf."

(402.) But this counter-current, also, is felt on the Cuban side sometimes, probably all the way from the Bahama Old Channel. Of this we have several instances from the communications of Captain Livingston and others. The most singular of these, however, is that of Captain Loudon, of the brig *Perry*, on returning, in the latter part of November, 1827, from New Orleans to Liverpool. Captain Loudon had made the *Iron Hills* in Cuba; shortly after noon he tacked ship to the Northward and Westward about 8 or 9 miles off shore; next day he kept beating to windward, as near to the middle of the strait as he could judge, and without sighting the land on either side, the wind then blowing a fresh gale from the Northward; and he continued beating in the same manner until about 8 a.m. of the second day, when, by *reckoning*, he ought to have been near the Salt Kays; but obtaining a lunar observation, it showed, to his astonishment, his longitude to be to the Westward of 83°. Supposing his observation to be erroneous, he took a second set of lunar distances, which gave a similar result. Still, however, doubtful, he stood on, and in a short time afterward gained soundings on the *Tortugas Bank!* The Northerly gale had now abated, and he worked his vessel in, on soundings, to the Northward of the Dry Tortugas. With a favourable wind he ran through the Tortugas Channel; but as light and baffling winds succeeded, he made for the Stream as it became dusk, and with such winds got through the strait in the two following days, having, on his way, found the current very rapid along the Martyrs or Florida Reefs. Captain Loudon justly remarked, that so extraordinary a circumstance, of which he was *positively certain*, ought to be generally known.

"Masters of vessels from Vera Cruz, &c., to Havana, often lengthen their voyage by keeping away too much to the Southward after rounding the Dry Tortugas, fearful of being carried away to the Eastward of Havana by the strength of the Florida Stream. Some have fetched in about the Port of Honda, the Cock's Comb, and one vessel even as low as Cape Antonio."—*Lieutenant John Evans.*

(403.) *Easterly Drift from the Gulf Stream, on the North and N.E. sides of the Bahamas, &c.*—The Gulf Stream about the Bahamas appears to have a drift or tendency to the Eastward; and there is reason to believe that an off-set of the Stream, from without the Matanilla Bank, sets, if not generally, very frequently, to the Eastward and S.E. It would seem as if the Stream, in passing Eastward along the Southern Florida Kays, still kept on this Easterly course with a considerable rate over the shallow Bahama Banks, and in the deep channels to cause very uncertain streams.

Captain Livingston said:—"The notices we have, tend to prove that an Easterly set-off from the Gulf Stream sets to the Northward of the Bahamas; of this I am so firmly convinced, that if in charge of a ship from Havana, or even New Orleans, bound to Jamaica, I should, if allowed to follow my own plan, run out of the Strait of Florida, and attempt making my passage with the aid of this set-off. This is to be understood, in case I should not have Westerly winds in the Southern parallels; for such winds are, I am told, more frequent than formerly; and I know that they are by no means of rare occurrence on the S.W. of Cuba."

(404.) The latter remarks would be adduced by many to prove that the surface of the Gulf Stream is *roof-shaped*, higher in the centre than at the sides, and that any floating body remaining inactive on it has a tendency to drift to its margins, especially to the Eastward and South-Eastward. How far this assumption will be borne out by more exact observation, it is difficult to judge, but there certainly seems to be some ground for the opinion, as its edges especially are marked by a larger collection of Gulf-weed and other drift matter than are found in the centre. Again, there seems to be a tendency for vessels to be floated to the East and S.E. without their knowing it. It has been urged by Captain Maury that this may be owing to the effect of the earth's rotation, which runs the current from under the ship, in the same way, as he says, the tendency of a railway train going North or South, is to run off the rails to the Eastward of its route. This was made the subject of experiment by M. Foucault and others; but we know so little that it were futile to argue on it.

(405.) In the Northern regions of the Stream, when the cold upon the land is in winter most intense, which is generally between December and March, heavy and continued gales very frequently prevail, which commonly proceed from between the North and West, across the course of the Stream, from Cape Hatteras until past George's Shoal, and bend its direction to the Eastward. Being aided at the same time by the discharge of the great bays and rivers, increased by the force of the wind blowing down them, and the constant supply of Stream along the coast of Carolina, the whole produces so strong a current to the Eastward as to render it impossible for a sailing ship to approach the coast until a change of wind commences.

During the prevalence of a Southerly or Easterly wind, which is not so common here, it has been found that the Current is forced close to, and in some parts upon, the edge of soundings; being thus pent in between the wind and the shoal grounds near shore, the breadth is greatly diminished, and the velocity proportionately increased. This circumstance has been in particular observed from about the longitude of Block Island, along the edge of the Nantucket Bank, thence beyond George's Bank, and also along the coasts of Georgia and part of South Carolina. In the first instance, the Southerly winds forced the Current to the edge of soundings, where it then ran from 1½ to 2 knots; and in the latter instance, the Easterly wind forced the Current upon soundings. With West and N.W. winds, the Stream would be removed some miles farther off.

The Survey steamer *Blake*, in July, 1880, when South-Eastward of Cape Romain, for 15 miles or more from the 100-fathoms line, experienced a strong current running to the S.W., dragging the vessel, with her trawl down in 142 fathoms, at the rate of 2 knots an hour. The same thing occurred in June, 1886.

From what has been said, it is clear that the eddies about the edges of the Stream must vary according to the circumstances above explained. Along these edges, but more particularly along the outer edge, there is generally a current in a different direction, which is accelerated by the wind in proportion to its strength, when blowing contrary to the Stream, and retarded, and perhaps altogether obstructed, by the wind blowing in the direction of the Stream. In the latter case the limits of the Stream will be extended.

In December, 1887, the barque *Grenada*, bound from Laguna to New York, found no current whatever in the Gulf Stream, experiencing strong head winds. Between February 14th—18th, 1888, the schooner *Elbridge Souther*, crossed the Gulf Stream area several times between lat. 28° and 33° N., and experienced no current, with N.W. and N.E. winds.

(406.) **Conclusion.**—We have thus described this famous Stream, perhaps at greater length than is needed, from its origin in the Caribbean Sea and Mexican Gulf to the offings of Cape Cod and Nantucket, a portion of its course much better known than any other, and more easy of definition, which is not the case with its farther progress.

The width of the Stream, between the Tortugas and Havana, has been estimated to average only about 40 miles, and not 1,200 feet deep, travelling with a mean annual velocity on the surface of 32·7 miles per day, as previously estimated in this work, or of 30·7 miles as calculated from the Meteorological Office charts.

Passing onwards to the Narrows of the Gulf, between the Bemini Islands and Cape Florida, distant 215 miles from the first section, we come to that part which, beyond contradiction, decides the whole character of the Gulf Stream, as the *whole of it* passes over this OUTFALL. The Stream is here 39½ miles wide, and the water above the temperature of 60° is about 1,200 feet deep in the centre of the Stream. The *sectional area* of the Stream in this part may therefore be taken at about 6·64 square miles.

Its *Velocity* here was calculated, in former editions of this work, to be about 65·4 miles per day on an annual mean; but the data of the Meteorological Department (1872) gave an annual mean of 48·0 miles per day (in *Spring*, 43·6 miles; *Summer*, 45·1 miles; *Autumn*, 46·8 miles; and *Winter*, 53·4 miles per day); which is contrary to previous calculations. The later American investigations make it about 72 miles a day in the axis.

Now, as the inference is that the colder substratum of the Gulf Stream is moving in a direction opposite to its course, that is, *Southwardly*, there is some point where there is no movement. Making all possible allowance for the decrease in velocity from 48·0 miles on the surface to 0·0 at the bottom (and this must be done in an empirical manner, and may be *much* overrated) the mean velocity of the whole mass will not exceed 36·25 miles per day. The sectional area of the Stream not exceeding 6·64 square miles, it follows that there are not more than 240·7 cubic miles of water passing per day over a given line in this part of its course.

Its mean rate of progress, when passing Cape Hatteras, is given as nearly the same as in the Narrows, 47·2 miles per day, though this is in excess of the velocities given at intermediate points. The surface water will take 13¼ days to pass from Cape Florida to Cape Hatteras, 630 miles apart; but if the whole mass maintains the same rate, it will not pass over under 17 days, and will be, at the annual mean, only 4·2° Fahrenheit cooler (varying from 10° to 1·2°). Off New York, it will be 10° cooler (varying from 17° in winter to 3·9° in August). Off Cape Hatteras the breadth of the Stream may be 120 miles, therefore it has expanded to a breadth of more than three times (3·3) its width at the Outfall, and its whole mass will make a bed of water 366 feet thick.

From this line to that of the section running S.E. of Nantucket, the distance is about 480 miles. On and near this section temperature soundings were taken by the United States Coast Surveyors, Commander Craven in 1854, Davis in 1845, and Bache in 1846, and their observations place us in a difficulty; for the warmer waters were not found to exist Northward of the parallel of 38° N.; the "Cold Wall" showed itself to the North of this, and then two less warm beds as far as 40° N. But the observations for current motion show its Eastern progress much farther than this, in fact up to 41° N. If we accept the lower estimate of its rate made by the Meteorologial Office, it will take 16 days to move the whole mass from Hatteras to Nantucket, or 33 days from the Outfall, though its temperature has only reduced from 12° to 18° since it left the Gulf of Florida. It is this rapid course, and consequent preservation of its original warmth, that has always made it so remarkable.

But while it has thus carried the Tropical heat so near to, and amidst the Arctic cold, its volume must be spread over a very much wider space, for its somewhat undefined breadth off Nantucket may be assumed at 300 miles, or seven times its original breadth; and if its velocity throughout were equal, it could only be 170 feet deep, but as its rate has somewhat diminished it may be taken as 200 feet; but then its surface has much cooled down, and the body of *warm* water cannot be assumed even as high as this calculation makes it.

The investigations in the *Blake* led Lieutenant Pillsbury to infer the volume of warm water passing the Narrows in 1 hour to be 89,872,000,000 tons, almost exactly one-half of this flow being within 100 fathoms of the surface. At the rate of 35 cubic feet of sea-water to the ton, this would amount to close upon 350 cubic miles of water per day, a considerable increase on the figures given above, but still insufficient to affect the argument to any appreciable degree.

(407.) This brings this wonderful Current down to the new phase of its character. Hitherto it has been a rapid heat-bearing stream, pressing on to the American coast, beyond the usual limits of where the division lies in other Oceans between the Westward tendency of sea and air within the Tropics, and the Eastward movements of extra-Tropical latitudes. Henceforth it leaves the coast on a due Eastward course to the South of the great collection of banks which lie off the British American possessions, and this portion of the Stream will be considered in the following pages.

(408.) **Eastern Extension** between about 68° and 48° W.—In examining the condition of the Gulf Stream, in the next 850 miles, we encounter many difficulties. Its physical features, the interferences it encounters, the opposing streams which neutralize its onward course, and the ever-varying rate of its current, have all to be taken into consideration. By confining the observations to those made, in the summer season, by the United States officers, off Nantucket, and to the current observations integrated by the Meteorological Office, it might almost be inferred that the Gulf Stream ceased between Nantucket and the S.W. part of Nova Scotia; for while the first makes the whole bulk of its warmer water to lie *South* of lat. 38° hereabout, the current observations show no Eastward drift to the *Northward* of that parallel in the same region. But the varying Easterly drifts, and the generally much warmer water which is found than is due to the latitude, will point to its origin. By the rapid transport of heated water into these regions by its Northern course, one feature is brought into existence which has not been sufficiently considered—that of the *Fogs* which characterizes the whole section now to be discussed. The Nova Scotia and Nantucket Banks, as well as the Newfoundland Great Bank, are proverbially regions of dense mist. The cool winds condense the evaporation from the warm Gulf Stream waters over thousands of square miles; and this process, as well known, is one of the most effective methods of cooling that can be imagined.

In addition, therefore, to the inter-mixture of an enormous bulk of cold Arctic water* in this part of its course, it has the no less active atmospheric agents at work on its surface in bringing down its waters to less than the normal temperature due to the latitude. The area, always more or less enveloped in fogs, and densely so when the prevalent N.W. winds blow, is not less than 20,000 square geographic miles in the offing between Nantucket and the Grand Banks, and this is leaving out of the reckoning all the other areas subject to the same chilling influences.

H.M.S. *Challenger*, in her deep-sea exploring expedition, twice crossed the course of the Gulf Stream in its Eastern portion; the late Sir Wyville Thomson remarked that where they crossed it, about 250 miles Eastward of the Chesapeake, the Stream was 60 miles in width and 100 fathoms deep. We presume that he considered the Stream had a river-like appearance to this extent.

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* Commander W. Chimmo, R.N., in 1868, found that the Arctic Current swept the rocky bottom bare on the Grand Bank and on the Flemish Cap, at the depth of 250 fathoms. He also found that the under-stratum of cold water was universal, and that the Gulf Stream was very superficial; thus, in lat. 44° 8' N., long. 48° 7' W., which would be in the main strength of the Stream, while the surface temperature was 61°, at 50 fathoms it was 43°, or 18° colder, and this in July. See Proceedings of the Royal Geographical Society, vol. xiii.

Temperatures (Fahrenheit) observed in crossing and recrossing the Gulf Stream, by H.M.S. Challenger, April and May, 1873.

Depth.	Bermuda towards Sandy Hook.					Halifax towards Bermuda.				
	34° N. 67½° W.	36° N. 70° W.	36½° N. 72¾ W	37½° N. 71½° W.	38½° N. 72½° W.	42° N. 63½° W.	41½° N. 63½° W.	39¾° N. 63½° W.	36½° N. 63½° W.	35° N. 64° W.
	°	°	°	°	°	°	°	°	°	°
At the Surface ...	65	65	75	52	50	47	59	67	72	71
50 fathoms	64	65	—	52	—	—	—	—	62	—
100 "	64	65	65	49	51	45	55	65	64	65
150 "	64	64	56	44	—	—	—	—	64	—
200 "	64	63	52	42	43	41	47	64	64	64
250 "	63	63	49	40	—	—	—	—	—	—
300 "	62	63	47	39	40	38	42	61	60	62
400 "	56	56	—	39	39	38	39	52	54	55
500 "	48	47	42	38	—	39	39	46	45	—
1000 "	—	—	38	—	—	37	37	—	—	—
1500 "	—	—	37	—	—	36	36	36	36	—
Bottom	35 (2850) fms.	—	—	35 (1750) fms.	36 (1240) fms.	37 (1250) fms.	35 (2020) fms.	35 (2800) fms.	35 (2650) fms.	— (2650) fms.

Taking a general view of the temperatures between St. Thomas and Halifax (each of which places lies on about the same meridian as Bermuda), it is to be noticed that the surface temperature gradually increased to the Northward and Southward of Bermuda; to the Northward by reason of the warm water of the Gulf Stream, till a maximum of 72° is found in 36½° N.; and to the Southward by reason of the lower latitude and the Equatorial Currents, until the surface temperature is found to be 79° at St. Thomas. Below the surface, however, a state of affairs was found to exist as follows:—At 100 fathoms below the surface—at Bermuda, a temperature of 66° was found; at St. Thomas, 70°; in 36½° N., 66½°. At 200 fathoms—at Bermuda, 63½°; at St. Thomas, 63°; in 36½° N. to 40° N., 63°. At 500 fathoms—at Bermuda, 46½°, which temperature continued the same to 40° N.; but at the same depth, in proceeding to the Southward, the temperature gradually decreased till at St. Thomas it was only 43½°, or 3° colder than that found 21 degrees of latitude to the Northward. This, although a small difference, must be due to the effects of the Gulf Stream. Proceeding to the Eastward from Bermuda, towards the Azores, the temperature of the surface water decreased gradually, and that at 500 fathoms remained pretty constant at 46½° for 700 miles.

Commander Bartlett states that the temperatures taken by the *Blake*, between Montauk Point and Bermuda, did not indicate, in August, 1882, any bifurcation of the Stream into warm and cold bands. The surface temperature increased gradually from 68° F. near the 100-fathoms line to 75°, and remained at 74° and 75° until the Stream was entered, when it rose as high as 80° and 81°, and continued at nearly the same temperature all the way to Bermuda. The bottom temperature in 266 fathoms was

40½°; at 1,174 fathoms, 37½°; at 1,500 fathoms, 36° to 36½°; and below this, 36° and 35½°, the lowest found.

Between Bermuda and Bahama, the surface temperature gradually increased from 68° to 77°, the bottom temperature being about 36°.

Series of temperatures, from the surface to the bottom, were taken during the summer of 1884, between Block Island and Bermuda, and thence to Hatteras. The isothermals showed the Labrador Current until nearing the Stream, when they descended gradually, and in the Stream itself abruptly, to the greatest depths. Instead of the warm Stream-water thinning away as it was reported to do when spread out, it was not much over 50 miles in width at the time of their crossing, as shown by the current and high surface temperatures.

The temperatures below the surface were much higher than at the same depths off the coast. The ordinary temperature at the bottom off Savannah and Charleston in 400 fathoms was 45°; at the same depth in the Stream, between Block Island and Bermuda, it was as high as 55°. To the Southward, the isothermals remained at almost the same depth as in the Stream, on the entire line to Bermuda. Just North of the Stream the temperature at 400 fathoms was 39½° and 40°. At a point well in the Labrador Current away from the Stream, the temperature at 400 fathoms was 38½°.

From Bermuda to Hatteras the isothermals were at the same depths as South of the Stream on the previous line, but when in the current off Hatteras, where the Stream trends to the Eastward, they rose to the same depth as off Charleston and Savannah on the plateau. These temperatures below the surface seem to suggest that the Labrador Current underruns the Stream at Hatteras, but at no other point. It probably keeps its Western boundary along the 1,000-fathoms line, and thus around the plateau towards the Equator.

The *Velocity* of the Gulf Stream in the section now under consideration is very various; but, as a mean, has been placed at from 26 to 36 miles per day. If this estimate is reduced to agree with those of the Meteorological Office Charts, 1872, as referred to in the main course of the Stream, these figures must be placed at about 20 or 27 miles respectively, and it would thus take about forty days to bring the Stream from off Nantucket to 48° W., a distance of about 850 or 900 miles. This would make a period of 72 days from Florida. But all such calculations must naturally be very vague, owing to the constant changes in the surface velocity of various parts of the Stream, and at various depths below the surface.

From February 16th to 19th, 1889, Captain Wall, of the steamer *Montreal*, in about lat. 37° N., Westward of long. 64° W., found the Stream setting due East, nearly 2 knots an hour, in spite of strong South-Westerly winds.

The *Limits* of the Stream have now become a subject of great difficulty. Formerly it was thought that its waters flowed Eastward as far South as lat. 36° or 37° between longitudes 65° and 55° W., but with a feeble current. But in the Meteorological Office Monthly Charts, of 1872, there is positively no evidence of an Easterly set to the Southward of lat. 39°

beyond longitude 60°. This adds very much to the complexity of the problem of how the warmer waters of the Gulf Stream can possibly reach the coasts of N.W. Europe, as strenuously claimed for them by some. The Northern margin is known to be in a continual struggle with the Arctic Current, which sets at right angles to its course with about an equal velocity; and, therefore, a mere verbal account can give but little definite information.*

With this uncertainty about its limits or existence in some parts, it is evidently difficult to estimate its breadth; but, according to the generally received extent, it may be about 300 or 350 miles on the meridian of 48° W., a most vague amount, but which makes it about eight times the breadth that it was in the Narrows of Florida; and, as its mean velocity is less than one-half of what it was at the commencement, it follows that the whole body of water passing Florida will not be more than 20 or 25 fathoms deep over such a line; and, as its temperature is lower on the surface at the Eastern part of the course in question than it was at its commencement, it follows that the film of *warm* water it sends up here cannot be more than a few inches in thickness. The area supposed to be covered by it between Nantucket and long. 48° W. is not less than 280,000 square miles; and, therefore, 240·7 cubic miles (see page 414) poured over this per diem will make a stratum of about 5¼ feet thick per diem. If the larger figures of the American observers on this point be accepted, or about 350 cubic miles per diem, the addition to the thickness of the stratum does not amount to much.

Temperature.—There is one singular fact—elicited by later researches, and by a comparison with the Current Charts of the Meteorological Office—which is, that the main body of the warm water, which has been traced along the United States coast, bears off in a due Easterly course Southward of the parallel of 38° N.—that is, directly across the ocean (not on a Great Circle course, but to the Southward of it) toward the Strait of Gibraltar; and this, too, where there is not the *slightest evidence of an Easterly Current* on the former monthly or annual mean charts of the Currents. This is very remarkable, and well deserves attention from those who study the distribution of Ocean warmth. There can be no doubt of the fact, since Maury, Rennell, Andrau, and the Meteorological Office, all agree on the point.

(409.) The late Dr. Petermann, who gave an immense amount of study to the subject, drew up two charts to illustrate his views, taken from the mean values of Maury's and other charts, for the months of July and January. On the July chart, the core of the Gulf Stream (*Kern des Golfstroms*) shows the form of a tongue, of a temperature of 81·5° (at some places even 84° was observed), extending North of the Equator to the 38th degree of latitude. This may be called not only a warm, but, better, a hot stream. This hot stream thence continues as a double tongue, with a mean temperature of from 77° to 81·55° towards the North as far as the 40th degree of latitude (in one spot only), and towards the East to the 43rd degree of longitude; that is, far beyond Newfoundland. In January, the tongue of 77° reaches to lat. 37° and long. 70° 30′ W., and at the place where the East end of this tongue of 77° terminates in July, we find in January a temperature of 63·5° and 65·8°.*

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* At times the change from warm to cold surface water is very marked. Commander Chimmo found it decrease in going Northward, from 72° to 58° in 2¼ hours.

To this it may be added, that the East end of the tongues of warm water above mentioned are 300 miles South of the Southern edge of the Gulf Stream, as usually placed; and, as stated before, in a part of the ocean where no Easterly stream is felt.

The evidences of this portion of the Gulf Stream being much warmer than is due to the latitude, are much qualified by a reference to the Temperature Tables of Lieutenant Andrau, drawn up for the Netherlands Meteorological Institute. For January, the latitudes of these two "hot tongues" are 36° N. and 33° N. respectively. On taking the figures lying between these parallels, they show thus, premising that each temperature is given for the mean between each meridian 5° apart; the first being from 50°—45° W., the last to the right hand 20°—15° W.

Lat. 36°	—	—	63·7°	63·1°	—	61·2°
Lat. 33°	69·3°	65·8°	65·8°	66·4°	—	63·9°

These figures show that the temperature is very uniform nearly across the Ocean, and they accord almost exactly with those of our own Meteorological Office.

For July, the hot tongues are in the latitudes of 38° and 34° N., and the figures show a similar result; and from this it would seem that the main bulk of the hotter waters of the Gulf Stream is lost in mid-ocean, about the meridians West of 45° W.

It is, therefore, safe to affirm that Rennell was correct in his statement, that the portion of the Stream to the Southward of lat. 40° (he says 42½°), and long. 40°—30° W., drifts with an almost imperceptible surface movement, until it is lost in the neighbourhood of Corvo, where its temperature and attributes do not vary from those portions of the Atlantic manifestly far away from its influences.

(410.) It is with the Northern portion (North of lat. 40° N.) of the Gulf Stream, then, that we shall have to deal in its future course Eastward, and this is very much cooler than the hot core above adverted to. On the meridian of 50° W. the water in July is at a temperature of 70°, on the parallel of 40° N., and is only 45·5° at 300 miles to the Northward. In January these figures stand at 61° and 34° respectively, and thus in these 5° of latitude the water becomes cooler by 24·5° and 37°; and looking generally at the isothermal lines, it would seem as if they were crowded to the Southward by the land and the influence of the Arctic Current.

Arrived at the Grand Bank of Newfoundland, we meet with a totally new feature in its condition. It here encounters the full force of the Labrador Current, which setting Southward over the Banks with nearly equal velocity and bulk, cuts off the Eastward course of the Gulf Stream in all that part of the current which runs North of 42° or 43° N. The isotherms, derived from the immense mass of figures in Maury's thermal charts, show, as Dr. Petermann says, that the Polar waters set against and penetrate it like an immense wedge.[*] This cold-water gulf penetrates for 150 to 200 miles Southward of its general limit; and in July, which is the period when the Arctic Ice drifts down in the greatest quantities, this is most evident, as the Arctic water is not more than 48°, while that of the Gulf Stream to the Southward is 68° and upwards. In January, the period when the Arctic regions are entirely frozen, and no Icebergs descend into these Southern latitudes, the effects on the surface are not quite so manifest, but are equally evident as far South as lat. 38° N.

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* Mittheilungen, 1870, page 219; and Knorr, pages 42, 43.

Now, this "cold-water gulf" is no surface interference of a temporary nature. It is a strong permanent current, flowing to a greater depth than the Gulf Stream at all seasons of the year. That it entirely cuts off all the lower beds of the warmer water is demonstrated by the fact that Icebergs, 80 and 100 feet high, have been seen as far South as lat. 36° 10′ N. in April, 1829, and 38° 40′ in June, 1842. This shows that the more powerful Southern Arctic Drift, of which many evidences are constantly met with, in the summer months by the Ice-drifts, and in the winter by the cold water, must cut off the Eastward progress of this Northern portion of the Gulf Stream waters. It is very probable that a small portion of the warm water does get over to the Eastward of this in the "hot streaks" which are so remarkable; because, although the thermometer on the surface shows that there is no continuity in the waters on the East side of long. 48° with those to the West of that meridian, yet the current observations show that the drift is still, generally, to the Eastward.[†]

(411.) In January, 1890, Captain Williams, of the steamer *Montana*, bound Eastward, made some temperature observations of the surface water, and at a depth of 15 feet, showing a marked drop Southward of the Banks, between lat. 40° 40′ and 41° 40′ N., long. 52° and 48° W. Between 8 p.m., on January 23rd, and 4 a.m. on the 24th, the sub-surface temperature fell from 70° F. to 40°, and in the next 12 hours rose again to 70°, the distance traversed being about 200 miles. The maximum surface temperature was 64°, the minimum also 40°, the latter being found about the 51st meridian.

(412.) The position, depth, and angle of meeting of the Gulf Stream and Arctic Current is continually changing. Small differences in density will determine which water will over-ride the other, causing alternations of temperature, both horizontally and vertically. Not only are the alternations found within the supposed limits of the Stream, but also both inside and outside of it.

Possibly at times, owing to its greater density, the warm water of the

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[*] Mittheilungen, 1872, page 220; Knorr, page 48.

[†] It is quite certain that the surface motion is not of any great depth, and that at a few fathoms beneath the surface it is inappreciable to any ordinary mechanical means. There is direct evidence of this in the deep-sea sounding trials, and more especially in the electric cable-laying experience. In these, if there should be any under-currents of force or in different directions, it would be shown directly by their action on the submerged line. In the case of the telegraph cables, the refined dynamometric apparatus employed is, generally, so uniform in its evidence, that the question of sub-surface action may be said to have been settled by it.

Gulf Stream may dip below the cold but lighter water of the Arctic Current, as in the Northern regions warmer water has been found at a considerable depth below the colder water on the surface.

The same arguments may be used with reference to the bands of warm and cold water (395) met with in the earlier part of its course, where it come in contact with that branch of the Arctic Current, which is considered to have its course to the Southward, off the American coast.

In 1886, M. J. Thoulet, from observations taken from the French frigate *Clorinde*, concluded that where the Arctic Current meets the Gulf Stream at right angles, the water of the former, though colder, is a little lighter, so that instead of passing below the warmer water of the Stream, it mixes with it, almost entirely arresting its speed, and from thence to the North-Eastward it is merely a drift.

(413.) Up to this point we have said nothing about the speculations promulgated respecting the heat-bearing properties of the Gulf Stream; but, in this book, space will not allow us to enter upon them. Those of Mr. James Croll, however, must be noticed, as they refer to a method of estimating this by the powers of absorption of the sun's rays by the ocean's surface, represented by the dynamic enumeration of foot-pounds. But we would deferentially demur to his calculations. He takes no account of the time it takes for the water to circulate, or of its ascertained depth. He very much exaggerates the known volume of the Stream, and does not refer to the interferences it encounters, the fog banks, nor to the Arctic or Labrador Current. However valuable his suggestions may be, they must be applied in a different way.*

(414.) Having thus brought the Gulf Stream through its remarkable and well-defined course, which on its Northern margin is not less than 2,200, miles, we arrive at the conclusion, which is here repeated from our former editions, *that its farther progress as a distinct current cannot be traced.* It merges into the general ocean drifts common to the sea for many hundreds of miles on either side of it. This conclusion is in antagonism with that of many who contend for its extension and evidences up to the shores of N.W. Europe, and into the Arctic basin. But while the facts on which this conclusion is based are not for one moment questioned, yet their connexion with the stream, which has thus far been described, is not shown, and the effects claimed for it are so immeasurably greater than the parent source, that they must be inevitably referred to much more powerful causes. These will be briefly discussed in the ensuing section.

9. NORTH-EASTERLY SET TO WESTERN EUROPE, ETC.

(415.) The previous pages have brought the Gulf Stream up to the meridian of 50° or 48° W. The Southern portion of the Eastward Current, Southward of lat. 40° N., passing over towards the Azores, with the other drifts, forms the head of the North African Current (265), while the portion North of that parallel ceases as a heat-bearing stream on the same meridian. Its further progress is manifestly entirely cut off by the very much deeper Arctic Current; and this is the case throughout the year.

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* See "Geological Magazine," vol. vi., April, 1869; and "Philosophical Magazine," February, 1870.

But it is contended by Dr. Petermann, that as the ocean becomes suddenly warmer to the Eastward of the meridian of 48°, and this, too, for an extent of not less than 300 or 400 miles in a N.N.W. direction in July, or N.N.E. direction in January, as shown by the direction of the isotherms, this warmer water must be the Gulf Stream.* Undoubtedly, looking only to the direction of the isotherms, there would seem to be grounds for this assertion; but the positive fact that the Polar Stream entirely intersects it, and that there is not the *slightest evidence of any Northerly set* to the East of the Great Bank (on the surface at least) precludes such a supposition. The *Eastward* course of the surface waters is continued alike over the colder as over the warmer areas; and as the surface temperature we are discussing must be dependent in some degree on surface motion, there must be some other great agent at work to produce this effect. How this operates is not clear; and, like many other mysteries of the Ocean, it awaits an explanation. It is certainly not caused by surface current.

Looking at the general arrangement of the isotherms, it would seem as if the waters of the Ocean South of the parallel of 45° or 50° N. latitude, and Eastward of the 40° meridian, were at their normal temperature, and that it was the effect of the Polar Stream, and the arrangement of the land on the Western side of the Ocean, that broke up the symmetry, by forcing the warmer waters several degrees of latitude Southward of the position they would occupy but for this combination of causes.

The rate of the drift is from 6 or 10 miles to 20 or 24 miles per day; and as far as 50° N. it seems generally to flow due *East* towards the French and Portuguese coasts, and thus forms the head of the occasional Rennell's Current. But, singular to say, observations are not abundant hereabout, and the true rate can only be given approximately; it is of no great power, and has but little effect on a vessel's course. Beyond the doubt, whether the water thus far can be considered as the Gulf Stream, there is no controversy as to this part of the Ocean circulation.

(416.) It is to the N.E. of this that there is a difference of opinion. It was generally believed, in former times, that the climate of the Western portion of the British Isles, that of Norway, Iceland, and a large area around the Northern part of Europe, was dependent on the Gulf Stream, which flowed continuously throughout as a heat-bearing current; but this cannot now be maintained, since we have been made intimately acquainted with the dimensions and character of the Stream in its greatest strength.

(417.) **Bottles.**—The observations for its Velocity and Direction are not very numerous; and, therefore, we have recourse to the drift of floating bottles, about which much controversy took place, at the time they were collectively brought forward in the "Nautical Magazine," in 1853. As they tell a singularly consistent tale, which is entirely confirmed by similar experiments in the Southern Hemisphere, their testimony must be brought into the question. See (243), page 295, *ante*.

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* "It is by no means annihilated (by the Polar Stream); on the contrary, it sallies forth intact from the conflict." "Again: "The Gulf Stream is not disturbed to any degree, either in its direction or in its temperature, until a very short distance East of Newfoundland, when it bends sharply round to the *North*."—Mittheilungen, 1870, page [illegible] Knorr, pages 43, 44.

The following statement of the drift of bottles is derived from Captain Becher's Bottle Chart. Many of the particulars contained in it have been given in our former editions, but they are here given entire in order that an estimate may be formed of the strength of the current in which they have drifted. It may be premised that the length of their courses is given in the shortest or direct distance. It therefore underrates their progress, as they have doubtless not generally pursued the shortest track to their destination:—

Ship.	Signature.	Where left.			Where found.	Interval Days.	Distance in Miles.	Rate per Day.
		Year.	Lat. N.	Long. W.				
			°	°				
Osprey	McGill	1822	49·6	12·5	Wales	36	270	7·5
Wallace	Robertson	1835	52·2	15·0	Ushant	130	450	7·2
Tyne	R. Hope	1834	46·6	16·9	Devon	71	600	8·4
Kent	W. L.	1836	50·3	19·0	Boulogne	126	890	7·0
Niger	Merret	1839	48·2	18·9	Quiberon	177	700	4·5
Bolivar		1840	46·9	18·6	France	94	700	7·0
Mary	Lock	1832	44·2	18·0	France	310	700	2·2
Ibbetson	of Stockton	1826	55·5	18·3	Killala	59	300	5·0
President	Scott	1836	48·5	19·6	France	128	650	4·1
Virginia		1838	42·2	19·3	Cork	45	750	17·0
Persian	Mallard	1834	47·1	20·4	Ireland	113	600	4·1
Albert	Robertson	1822	47·3	21·9	Somerset	186	820	4·3
Ardent	Duncan	1824	57·0	24·5	Lewis	171	610	3·6
Superior	Munson	1842	53·8	24·0	Dunnet Head	175	800	5·0
Enterprise		1833	45·1	24·3	France	316	980	3·1
Mary	Godfrey	1840	47·3	27·4	Clare Island	111	850	7·7
Orbit	Boot	1811	46·8	27·0	Ireland	330	860	2·7
Romulus	Crawford	1819	57.8	30·7	Shetland	110	1000	9·1
Helen	Butman	1834	47·3	33·6	Scilly	179	1150	6·4
Sandwich	Squire	1821	50·3	36·4	Hebrides	184	1100	6·3
J. Cropper	Marshall	1824	48·3	38·1	Mounts Bay	398	1230	2·4
Seine		1811	50·7	40·3	Kerry	274	1130	4·5
British Queen	Hamilton	1838	43·9	44·5	Newport	66	1700	25·7
Royal Union	Grant	1822	48·2	45·2	Scilly	75	1450	19·9
Elizabeth	J. E.	1819	47·0	49·2	Rathlin Isle	311	1600	5·0
Victoria		1834	45·0	50·0	Land's End	215	1760	8·2
Alexander	Parry	1818	59·1	52·3	Staffa	437	2400	5·5
Alexander	Parry	1818	62·0	54·0	Donegal	416	2600	6·2
Newcastle	Napier	1819	38.9	64·0	Ireland	356	2700	7·3
J. Esdaile	King	1821	36·9	71·8	Lancashire	495	3000	7·0
R. de Holland	Groeneld	1850	46·0	20·5	Glandore	345	680	2·0
Jessy	Cook	1846	50·6	20·5	Brest	59	480	8·0
	Johnstone	1847	47·3	21·7	Brest	206	700	3·5
Delia	Adey	1842	50·0	26·0	Ireland	138	600	4·6
Normandie	Spalding	1844	57·1	33·2	Norway	228	1400	6·1
Graham	Beach	1847	51·1	45·5	Barnstaple	233	1560	6·7

These bottles, taken from Captain Becher's list in the "Nautical Magazine," 1853, have been selected from those which have made the ordinary drift. The chart which shows their direction points most clearly to the Eastward and North-Eastward drift, although the average rate is not high, being for the above 6·6 miles per day, probably below their actual rate.

Some more recent examples may also be given, and reference should also be made to the Drift diagram, page 297.

A bottle dropped from the steamer *Sardinian*, October 31st, 1889, in lat. 56° 6′ N., long. 17° 24′ W., was picked up in February, 1890, in lat. 69° 28′ N., long. 18° E., on the coast of Norway, having drifted about 1,250 miles to N.E. by N. ½ N.

A bottle dropped from the steamer *Saturnina*, June 27th, 1889, in lat. 50° 15′ N., long. 34° 17′ W., was picked up on the beach near Carnsore Point (Ireland), on February 13th, 1890, having drifted about 1,080 miles to E. ½ S.

On September 1st, 1887, a bottle paper was set adrift off Hull, Massachusetts, and was picked up on the beach near San Fernando, Cadiz, February 28th, 1892. The great circle distance from port to port is 2,975 miles, but its probable drift was nearer 4,000 miles, even if it had not made the circuit of the Atlantic.

Another good example of this drift is shown by the track of the schooner *W. L. White*, lumber laden, which was abandoned Eastward of Delaware Bay, March 13th, 1888, and ultimately drifted right across the Atlantic, and went ashore on Haskeir Island, one of the Hebrides, January 23rd, 1889. The most remarkable feature is the zigzag track she followed in mid-ocean, between lat. 44° and 51° N., long. 33° and 44° W., from the beginning of May till the end of October. Previous to this time she followed a course about E.N.E., at an average rate of about 32 miles a day, and subsequently she moved East and N.E., 1,260 miles in 84 days, an average of 15 miles a day; but during the long interval of six months she remained within this comparatively small area, drifted back and forth by the Gulf Stream and the Labrador Current, and tossed about by the varying winds, a constant menace to navigation along the greatest highway of ocean commerce in the world. During these six months alone she was reported by 36 vessels, three of which sighted her in a single day. In her cruize of 10 months and 10 days she traversed a distance of more than 5,000 miles, was reported 45 times, and how many more vessels passed dangerously near her at night and in thick weather it is impossible even to estimate.

The schooner *Twenty-one Friends*, found abandoned, March 24th, 1885, about 160 miles Eastward of Chesapeake Bay, was drifted to lat. 51° 30′ N., long. 27° 40′ W., in 4½ months, or a distance of 2,130 miles to E.N.E. Thence she drifted to the Eastward and South-Eastward towards the North coast of Spain, and was last reported on December 4th, 1885, about 130 miles N.N.E. of Cape Finisterre, having drifted 3,525 miles in 8 months and 10 days.

On December 8th, 1887, a gigantic raft of timber left the Bay of Fundy, in tow of a steamer for New York. It consisted of about 27,000 baulks of timber, each 50 to 100 feet in length, bound with chains into a raft 560 feet long, 65 feet wide, and 38 feet deep, drawing 19½ feet water, and estimated to weigh 11,000 tons. On December 18th, a Hurricane was encountered about 40 miles S.S.W. from Nantucket South Shoal lightvessel, and the raft got adrift. It rapidly broke up, and the logs drifted away to the Eastward, gradually spreading over a fan-shaped area between lat. 30° and 40° N., though many logs were reported to the North-Westward of the Azores in May, 1888.

On June 12th, 1888, a spruce log drifted ashore at the island of Fayal, in the Azores. On September 4th, 1888, a vessel passed through a number of floating logs, about 100 miles Northward of Madeira.*

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* *Current Floats.*—In the summer of 1889, the United States Coast Survey steamer *Blake* set adrift a number of floats between Cape Hatteras and George Shoals. They consisted of a weighted staff, carrying five glass tubes, each enclosing the usual document. Any person finding one of these at sea was requested to remove only *one* of these tubes, and then set the float adrift again.

It will be observed that the velocity of the drift varies greatly, a long course having been performed at a mile an hour and upwards, while in other cases its progress would be inappreciable in the navigation of a ship.

There is a very marked feature, that of the Eastward, and not North-Eastward tendency, as might be inferred from the prevalence of the S.W. winds.

(418.) Of this Eastward tendency of the waters on the Eastern side of the North Atlantic Ocean there can be no doubt, and this is the great question to be elucidated, which, from its large extent, cannot be fully discussed here. This fact is manifested by abundant proofs. Besides the greater warmth of the water, which diminishes as we proceed Westward, there are Tropical products, such as seeds (the beans of *mimosa scandens*, cocoa-nuts, &c.), which are frequently washed ashore at the Færoe Islands, Iceland, Norway, &c., all proving a South-Westward origin.*

(419.) The arrangement of the isothermal lines on the Ocean North of 45° or 50°, as shown by Dr. Petermann's charts, as well as by all other physicists, shows that a great change occurs in the static condition of the water North of lat. 50° throughout the year. Instead of the lines of equal temperatures running East and West, they have a N.E. and S.W. direction, nearly to Spitzbergen. On referring to the Wind diagrams, given at page 171, it shows that the winds hang generally to W.S.W., or between S.S.W. and W. by N.; and as these South-Westerly winds have the greatest force, they have the greater effect on the climate of the countries under their influence. But when it is known that the water is warmer than is due to the latitude, to a depth perhaps of 500 or 700 fathoms, it is a manifest impossibility that the Anti-Trade wind can be the transporting agent.

In the absence, then, of any clearly assignable cause for this elevation of the temperature, it must be considered *that the whole body of the upper strata of the ocean-water, on the Eastern side of the North Atlantic Ocean, is drifting to the Northward.* To assign this cause to the Gulf Stream is to ignore the statistics of the Stream; and it is again affirmed that this very marked stream-current should have a distinct designation.† As the area which is now claimed to be raised in temperature by the Gulf Stream far exceeds 1,500,000 square miles, it follows that the quantity of water which passes along the American coast, which can reach it, cannot cover it to a greater depth than 6 inches per diem, and this after a period of one, two, or perhaps three years, through the fog-banks of N.E. America, and through the Labrador Stream.

(420.) As Dr. Petermann, by his valuable labours, has helped to throw

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* General Sabine, when at Hammerfest, in 1823, saw some palm-oil barrels drift ashore, supposed to be from a vessel wrecked at Cape Lopez, in the preceding year.

† Dr. Petermann suggests that the term "Gulf Stream" should be used for this European current, and that the true stream should be called the "Florida Stream." But this is reversing the argument. The real Gulf Stream has been thus known from the earliest times, and the term has only been applied of late years to the European current.

Ocean, along the Norwegian coast, cultivated land up to 71° N., the Northernmost land of the world in which, under the influence of the Gulf Stream, agriculture is the main occupation of the inhabitants. Wheat is grown up to Inderöen, in lat. 64° N.; barley up to Alten, in 70° N., where sowing generally is done between the 20th and 25th of June, yielding in the short space of eight weeks, to the 20th or 30th of August, on the average six or seven fold; the potato yields, at the same place, on the average, seven or eight fold—in favourable seasons, even twelve to fifteen fold; it thrives on the coast as far to the East as Vadsö, on the Russian boundary line. At Alten (70° N.) relishable cauliflower is raised even in less favourable summers."

(421.) On the vexed question of the influence of the sea on the Climate of the British Isles much cannot be said here. In an essay, by Mr. Nicholas Whitley, C.E.,* he arrives at this conclusion respecting it:—"Our S.W. wind has its birthplace where the temperature of the sea is at least 55° in January, causing the thermometer on the Cornish coast, under its influence, to stand steadily at 52°, and the great warmth of the past winter resulted from the continued persistency of this wind rather than from any excess of heat inthe sea.

"The S.W. wind gives to Penzance a mean winter temperature of 44°, being the same as that of Montpellier; Cork falls short of it by only half a degree; and the mean temperature of the Scilly Isles at this season exceeds that of this noted winter resort by 2½°."

In a farther examination of the log-books of the Cunard steamers, sailing between Liverpool and New York, for a period of five years, which results have been carefully tabulated, he says, "The extent and greatest intensity of the Arctic Current is sharply shown by the thermometer in every voyage. The cold water on the Banks of Newfoundland reaches its mean monthly minimum of 30° in January, and its mean maximum of 52° in September, and its width is fully 400 British miles.

"On the Eastern side of the cold current, and in close proximity to it, there is a bed of very warm water, having a mean temperature in January of 57°, being 27° warmer than that on the Banks, over a width of about 200 miles. This appears to be a strong eddy of the Gulf Stream, curving Northward, and holding the Arctic Current in its warm embrace.

"From this part of the sea to near the Irish coast the warmth is more equally distributed through the water, and the thermometer does not detect any well-defined branch of the Gulf Stream flowing to the N.E. There is, however, a decided rise in the temperature about the middle of the North Atlantic Ocean, amounting to from 4° to 6° above that of the sea at Scilly, and the figures on the chart appear to indicate that it lies in a S.W. and N.E. direction. It is most probably the drift of the Gulf Stream driven to the N.E. by the prevailing S.W. wind.

"The means represented in the Table show that East of the cold water of the Newfoundland Banks (the Polar Stream, which has there a width of 400 miles, and a temperature in January of 30°, and in September of 52°), there is a warm bed of water, 200 miles in width, with a temperature of

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* See Proceedings of the Royal Geographical Society, vol. xiii., 1869, page 229, *et seq.*

57° in January and 61° in August. Between this bed and the Irish coast the temperature is more uniform ; there is, however, in the middle of this distance, in about longitude 25° West of Greenwich, a belt of water of a decidedly higher temperature."

(422.) What has just been quoted refers to the S.W. coasts ; carrying the views farther Northward, there is a very important meteorological paper of Mr. Alexander Buchan, Secretary to the Meteorological Society, " On the Temperature of the Sea on the Coast of Scotland," based on observations carefully collected from numerous stations, between January, 1856, and 1865, and the one great fact elicited is given as follows:—

The great excess of the temperature of the sea over that of the air in the North is perhaps the most remarkable fact in the meteorology of Scotland. It is a difference, moreover, as the following Table will show, which may be considered constant from year to year :—

	1857	1858	1859	1860	1861	1862	1863	1864
Mean annual temperature of the sea at Sandwick	49·5	49·4	49·4	47·5	48·6	48·6	48·8	48·1
Mean annual temperature of the air at Sandwick	47·5	46·0	45·7	44·1	46·3	45·8	46·4	45·5
Mean annual difference.....................	2·0	3·4	3·7	3·4	2·3	2·8	2·4	2·6

This Table teaches, if examined closely, the slowness with which changes in temperature of the air are completely propagated through the waters of the Ocean, in those Northern parts where the power of the sun's rays is greatly diminished.

When the tendency of the temperature of the sea to follow that of the air is considered, it can scarcely admit of a doubt that, if the waters of the sea were stationary round Orkney from year to year, their temperature would ultimately fall to that of the air, or at least to within about half a degree of it. But this is not the case ; there is some influence at work keeping the temperature of the sea 3° above that of the incumbent air. The enormous amount of heat sufficient to maintain the whole waters of the sea in the North from 2° to 3° above the air, must be brought from warmer latitudes by currents of some sort or other. Since, then, a sea current from the South must be conceded, what is the agent employed?

(423.) Hitherto we have referred but very slightly to the movements or temperature of the lower strata of the Ocean waters, but this very wide question has a most important bearing on our present subject. The very important investigations which were carried on in H.M. Ships *Lightning* and *Porcupine*, under the superintendence of Dr. Carpenter and Mr. Gwyn Jefferys, will be adverted to in a special section at the end of this book ; but, as connected with this portion of our subject, it may be stated that the voyage of the *Porcupine*, in 1869, demonstrated that there was a stream of warmer water, 900 fathoms deep, between Iceland and Spain, and equally as much near Rockall Bank. Between the latter and the Færoe Islands it reaches to the bottom, or a depth of 767 fathoms, and at this the temperature is 41·5°.

These last facts are conclusive as to this movement of warmer water not being the Gulf Stream. By what possible reasoning can it be inferred that this can be the Gulf Stream, as it is nearly five times as deep, and hundreds of miles broader than that stream is at its origin; and, as it has been before shown, it receives no "tributaries." We, therefore, repeat the assertion that this great Ocean current has a distinct origin, and should have a special designation.

We cannot pursue the question farther: it must be sought for in the numerous works bearing more especially on this subject, many of which have been referred to.

A subsequent Chapter, on the Depth, Temperature, &c., of the Ocean, may be referred to in connection with the surface and deep-sea temperatures of this great current.

In concluding this brief account of the most remarkable feature in Ocean physics, we can only express the hope that the combined observations of the recent investigations will place this science of *Rheology*, as it may be termed, on as firm a basis as its cognate branches.

10.—THE ARCTIC OR LABRADOR CURRENT.

(424.) The last section treated of the warmer Tropical waters which passed into the Northern regions, carrying with them their ameliorating influence on the Arctic climate. The present deals with the same waters as they emerge at a minimum temperature from these frozen regions, and bring their ice and cold into the grand system of Ocean circulation and compensation.

(425.) **Iceland, &c.**—In 1879, Lieutenant C. F. Wandel, of the Danish Royal Navy, published a pamphlet* dealing with his experiences during three years steam navigation around the coasts of Iceland, from which the following remarks are taken.

Near the coasts of Iceland the Currents are influenced by the tidal streams, which revolve round the island, the flood moving with the sun and the ebb against it, though the currents somewhat overcome the strength of the ebb, and the island is thus encircled by a constant current running with the sun. The investigations recently made by the officers of the Danish steamer *Fylla*, have added much to our knowledge of these seas. It is found that in the offing a constant comparatively warm current runs Westward and Southward respectively off the North and West coasts of Iceland, being bounded by the cold Polar Current which runs down the East coasts of Greenland and Iceland; the latter branch appears to continue along the South coast, and loses itself in Faxe Bay. At 74 miles due North of North Cape the cold current was found to reach from the surface to the bottom.

(426.) In *Denmark Sound*, between Iceland and Greenland, currents of distinctly different natures are found. The warm *Irminger Current* washes the Western and Northern shores of Iceland, but the cold Polar

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* "Bemärkninger til Beseiligen af Islands Kyster," Copenhagen, 1879. See also Thoroddsen's "Den Grönländska Drifisen vid Island."

Current of East Greenland is more difficult to define on account of the ice. Captain Mourier, who examined the latter current in 1879, in the Danish vessel *Ingolf*, always found a comparatively high temperature at the bottom, and the Nordenskiöld expedition of 1883 found the same, demonstrating that this cold current, between lat. 66° N. and Cape Farewell, flows on a bed of warm water proceeding poleward, the surface water being of less density than that of the warm. Its depth was found to extend to about half the depth of the sea in the places examined.*

(427.) The limit of the N.E. Drift about Iceland has been mentioned previously (420). To the West of this, then, we may place the great drift which comes down from beyond Spitzbergen, and transports the immense quantities of ice upon the Eastern shores of Greenland, which has generally rendered this, one of the most inclement regions of the world, unapproachable by ships. Several instances of this drift could be recited, but as it is not interesting to navigation, they need not be dilated on, though the Ice this current brings into the low latitudes is an important consideration in the navigation of the North Atlantic Ocean. This branch of the Arctic Drift, however, does not probably furnish many of those gigantic Icebergs, which, drifting down Davis Straits, float over and Eastward of the Newfoundland Banks, and far into the Northern margin of the Gulf Stream.

The estimated rate of this drift from Spitzbergen, calculated from the rate of vessels in the pack-ice, is from 8 to 14 miles per day.†

(428.) It was formerly considered that this S.W. stream, after passing Cape Farewell, the South point of Greenland, made direct for the coast of Labrador, and thence over the Newfoundland Banks. But Commodore Irminger, of the Danish Royal Navy, has demonstrated that it does not do so, but that it passes around Cape Farewell to the Westward, and thence passes Northward in a narrow stream along the shores of West Greenland, and is known as the *West Greenland Current.* It is considered that a branch of the Gulf Stream flows towards Davis Sound. This would strike the East Greenland Polar Current off Cape Farewell, carrying the ice brought by the latter to the Westward and Northward, its temperature and density thus becoming reduced as it proceeds Northward.

"If the current existed, which some writers state to run in a direct line from East Greenland to the Banks of Newfoundland, then the ice would likewise be carried with that current from East Greenland; if it were a submarine current, the deeply immersed icebergs would be transported by it; if it were only a surface current, the immense extent of field-ice would indicate its course, and vessels would consequently cross these ice-drifts at whatever distance they passed to the Southward of Cape Farewell. *But this is not the case;* experience has taught that vessels coming from the Eastward, steering their course about 2° (120 nautic miles) to the

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* A more detailed account of the observations of the Nordenskiöld Expedition of 1883, will be found in the "Proceedings of the Royal Geographical Society," October, 1884, pages 569—578.

† See A. G. Findlay, "On the course of Sir John Franklin's Expedition," in the Journal of the Royal Geographical Society, vol. xxvi., 1856, page 33.

Southward of Cape Farewell,[*] seldom or never fall in with ice before they have rounded Cape Farewell and got into Davis Strait, *which is a certain proof that there does not exist even a branch of the Arctic Current running directly from East Greenland towards the Banks of Newfoundland.*"[†]

The limits of this Spitzbergen Current, as it may be termed, are therefore indicated by the distance to which the ice it transports is found to extend, and from the examples cited may be taken, as above, to a distance of 120 miles South of Cape Farewell, and to 150 miles off the Danish settlements of S.W. Greenland.

(429.) In the space of Ocean between the Southern limits of this current and the known South-Easterly drift down the Labrador Coast, an anomalous condition seems to exist; we have no notice of the set of the streams, if any, within it, but its characteristic seems to be the *drift-wood* within its area. These floating relics have evidently a Southern origin, and point also to the truth of the statement that a warm current sets toward and past Iceland.

"Another proof that the current from East Greenland does not run in a straight line towards the Banks of Newfoundland, is also derived from the observations of the temperature of the surface made on many voyages to and from Greenland.

"Supposing that the Arctic Current from East Greenland pursued its course in a straight line towards the Banks of Newfoundland, it would be crossed, on the voyage from Copenhagen to the Danish colonies in Greenland, between 38° and 45° W., and so high a temperature in the surface of the Ocean as from 4° to 6° R. (41° to 45·5° Fahrenheit), as is found only on this route, would, according to my opinion, be impossible only 1° or 2° to the Southward of the parallel of Cape Farewell; as it is a well-known fact, that the principal Ocean currents maintain their temperatures through very considerable distances of their courses.

"This comparatively high temperature of the surface of the Ocean, so near to the limits of that current which carries enormous masses of ice from the Ocean near Spitzbergen round Cape Farewell, warrants my opinion that the waters of the North Atlantic Ocean, move in a North-Westerly or Northerly direction, towards the Eastern and Southern coasts of Greenland, and that this indraught towards the land is undoubtedly the cause of the ice being so closely pressed on to these coasts as it is so frequently on the South coast, and almost constantly on the East coast, rendering the Eastern coast entirely inaccessible from seaward.

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[*] An observation which it is interesting to mention here, and which gives a proof of the very little difference between the temperature of the surface and that at some depth, is mentioned in the voyage of Captain Graah, page 21. He says, "The 5th of May, 1828, in lat. 57° 35′ N., and 36° 36′ W., the temperature of the surface was found 6·3° R. (46·2° Fahrenheit), and at a depth of 660 feet 5·5° R. (44·5° F.)." This proves that there is no cold submarine current in the place alluded to, to the S.E. of Cape Farewell. A still more conclusive experiment was recorded by Sir Edward Parry, in the account of his first voyage, June 23, 1819; in lat. 57° 51′ N., long. 41° 5′, with a very slight Southerly current, the suface temperature was 40½° Fahrenheit; and at 235 fathoms 39°, a difference of only 1½°.

[†] "Journal of the Royal Geographical Society," vol. xxvi., pp. 40, 41.

" From the foregoing it seems to me to be demonstrated that the current from the Ocean around Spitzbergen, which carries such considerable masses of ice, after it has passed along the East coast of Greenland, turns Westward and Northward round Cape Farewell, *without detaching any branch* to the South-Westward directly towards the Banks of Newfoundland. *

" This current afterwards runs Northward along the S.W. coast of Greenland until about lat. 64° N., and at times even up to Holsteinborg, which is in about 67° N."†—*Admiral Irminger.*

(430.) This current, then, after drifting over the Northern Atlantic Ocean, passes up the Eastern shore of Davis Strait to and beyond the entrance of Baffin's Bay, between Cape Walsingham and Holsteinborg It here encounters the *Southern* set which passes down Baffin's Bay, especially on its Western side, transporting those immense icebergs which are annually launched from the glaciers of West Greenland and other parts, as described by Dr. Rink. This current, which enters Baffin's Bay, especially by Lancaster Sound, is the grand outlet of the waters which runs from West to East through the Labyrinthine Archipelago, once the scene of the exciting search for the expedition of Sir John Franklin, and is unquestionably the continuation of that drift past Spitzbergen, described previously (419.)‡

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* Graah says in his Narrative (page 23, English translation):—" In the mouth of Davis Strait I found the temperature of the surface of the Ocean from 4° to 3·1° R. (41° to 39° Fahrenheit), though we were in the proximity of the ice. From this I concluded that a current from the *South* predominated here, because I never before in the vicinity of ice had found the temperature of the water exceeding 1·8° R. (36° F.), and this conclusion was confirmed when, coming to the Northward of the ice, I found the temperature of the water 1·1 R. (34·5° F.)."

† Besides the evidence afforded by the Ice-drifts and the Temperature of the water, as cited by the author, conclusive proof of a Northerly set is found in the drift-wood which has been so frequently met with around Cape Farewell and off the West coast of Greenland. A few examples will suffice. A plank of *mahogany* was drifted to Disco, and formed into a table for the Danish governor at Holsteinborg (" Quarterly Review," No. xxxvi). (But Admiral Sir Edward Belcher thought that this plank is not mahogany, but black-birch, and therefore a Siberian product. If it had made such a lengthened voyage as that from the Gulf of Mexico, it would have become worm-eaten.) Admiral Löwenörn picked up a worm-eaten mahogany log off the S.E. coast of Greenland. Captain Sir Edward Parry, in his second voyage, September 24th, 1823, picked up a piece of yellow pine quite sound, in lat. 60° 30′, long. 61° 30′ W., and on his third voyage seven pieces of drift-wood were found in the vicinity of Cape Farewell. Again, Captain Sir John Ross found much drift-wood around Cape Farewell, and Captain Sir George Back saw in lat. 56° 50′, long. 36° 30′, a tree with the roots and bark on. These instances might be multiplied; but, as before stated, it is very probable that the drift-wood comes from the Northern coast of Asia.—Ed.

‡ So confident is Dr. Fridtjof Nansen, the famous Danish Arctic Explorer, in the origin of this current, as here described, that he has fearlessly undertaken, in the specially constructed vessel named the *Fram*, to enter the ice with this current somewhere near the New Siberian Islands, and then drift with it. It is devoutly to be hoped that this venturesome scheme, commenced in the summer of 1893, may turn out successful. The vessel carries a crew of twelve men, with supplies and equipments for five or six years. For a full account of this expedition, the reader is referred to a paper by Dr. Nansen, in the " Geographical Journal," January, 1893, pages 1—32, entitled " How can the North Polar Region be Crossed ?"

It thus brings into warmer latitudes all the ice which remains from the melting influences of the Arctic summer, and also is continually floating Southwards that which collects in Baffin's Bay and its inlets. Its Southward drift is constant, winter and summer, as demonstrated by the drift of several vessels of the Arctic searching squadrons—as the Grinnell Expedition, Sir James Ross, H.M.S. *Resolute*, Sir L. M'Clintock in the *Fox*, &c. A more recent example is that of Captain Tyson and nineteen of the crew of the U.S. vessel *Polaris*. On October 14th, 1871, they became separated from their ship in lat. 77° or 78° N., South of Littleton Island, and drifted on a floe for more than 1,500 miles, being rescued about 6 months later, on April 30th, 1872, by a sealing steamer near the Strait of Belle Isle. They supported life by hunting and fishing.

About 10 miles per day may be taken as the drift down Baffin's Bay, as estimated by the author in the "Journal of the Royal Geographical Society," quoted previously.

(431.) The Baffin's Bay Current and Spitzbergen Current having united, set with great force down the coast of Labrador, the Westward tendency being probably owing to the earth's rotation, which here rapidly increases Southwardly in these parallels. It sets along the Labrador coast at rates varying from 10 to 36 miles a day, but is very much influenced by the winds near the coast. When navigating near the East coast of Newfoundland, with Easterly and N.E. winds (which are accompanied by thick weather), mariners must guard against a strong indraught into the great bays of this coast.

(432.) But the chief interest of this current to the sailor is the drift ice and great icebergs which it floats Southward across his track, constituting one of the most formidable dangers of the Transatlantic navigation. As this is the most important feature it has, it will be dilated on more fully hereafter, as the limits within which these ice-drifts are liable to be encountered are also the limits of the cold Arctic Current now being discussed.

(433.) The waters of the Arctic Ocean are thus brought again into that system of circulation which gives to sea-water a universal character (246). In former years it was not thought that its effects extended farther than this, and the cool S.W. current inside the Gulf Stream was considered to be an eddy of that great current, whose temperature was dependent on the shallowness of the soundings, in contradistinction to the supposed unfathomable depths of the Gulf Stream. Captain Pornton, as stated in the earlier editions of this work, had, however, been led to conclude that the Southward drift past Newfoundland, and the current from the Gulf of St. Lawrence, with the eddy from the Gulf Stream, combined to form the counter-current in question.

Its true character was first argued out by Mr. W. C. Redfield, a name well known to science. He drew up a summary of remarks and suggestions for the observers of the United States Exploring Expedition, under Captain Wilkes, in 1838, and which was read before the American Philosophical Society in May, 1843. From that paper we will make a few extracts:—

"From what source is that South-Westerly current derived, which commonly prevails along the coast of the United States, in the direction which is opposite to the Gulf Stream?

" I am aware that it is usually considered by seamen as an eddy current derived from the Gulf Stream; but from this view I am compelled to dissent. For, in the first place, this current never assumes the gyrating form of an eddy; but continues its course, when unobstructed by gales, in a direction which is generally parallel to the coast. But, secondly, in case this current be derived from the Gulf Stream, it must necessarily partake of the same elevated temperature; whereas the reduction of temperature which occurs on crossing the North-Western limit of the Gulf Stream is most remarkable, and is almost without parallel in the Atlantic, except in the immediate vicinity of ice.

" It appears vain to allege the proximity of soundings or shallows as explaining this extraordinary change of temperature, for this cannot avail if the waters of the counter-current be derived from the Gulf Stream, to say nothing of the erroneous character of the position here noticed.

" From the evidence which is afforded by numerous facts and observations, it appears that the current in question is neither more nor less than a mere sluggish prolongation of the *Polar or Labrador Current*, which sweeps along the North-Eastern shore of this continent and the Island of Newfoundland; and this current, if I mistake not, may be traced in its gradations of temperature, by the thermometer, from off the Southern coasts of Newfoundland and Nova Scotia, through the entire distance, to Cape Hatteras, if not to Florida.

" An eddy current, off-setting to the Gulf Stream, would nowhere be so likely to be met with as at the point of intersection of this Stream with the extremity of the Grand Bank of Newfoundland, and sweeping from thence upon the Southern shores of the island of that name; and yet the harbour of St. John's, in the Southern part of Newfoundland, is known to have continued ice-bound, in 1831, so late as the month of June, although in the latitude of Paris. This fact is a convincing proof of the unimpeded continuation of the Polar Current to the Southward, in this region, notwithstanding the near proximity of the Gulf Stream."

H.M.S. *Challenger* proved the correctness of this theory. In May, 1873, when 210 miles S.S.E. from Sandy Hook, proceeding to the Northward, Sir Wyville Thomson says,* " Although on the surface the influence of the Gulf Stream was still felt to a certain extent, the contrast between the observations of this day and the day before was most marked. We had crossed the 'Cold Wall,' and the temperatures registered were almost purely those of the Labrador return current. . . . The collection as a whole had a decidedly Arctic character and recalled some of our dredgings on the coast of Northern Europe, although it seemed that few of the forms were absolutely identical." The temperature soundings (p. 416) will give an idea of the way in which the cold water underlies the warm in this region.

(434.) The *Velocity* of the Arctic Current, over the Banks and to the Southward of Newfoundland, is very variable, but at times is great. We can rather argue from its effects than from direct observation; for one result of this influx of warm water into a cold region is the production of dense Fogs so peculiarly characteristic of the Banks. "Bank Weather" is not favourable to astronomic observations, and hence the paucity of them, and the difficulty of forming accurate estimates.

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* " Voyage of the *Challenger*," vol. i., page 375.

(435.) Upon a survey of the *Virgin Rocks*, in July, 1829, the Current at about 80 miles E. by S. from Cape Race was found setting over them to the W.S.W., at the rate of a mile an hour. During the survey of these banks, in July and August, 1879, by the officers of H.M.S. *Gulnare*, little current was experienced, a slight set to the Southward only being perceptible, except in the immediate neighbourhood of Virgin Rocks and Eastern Shoals. Round these the fishermen report a regular tide, running to the Westward in the morning, and changing gradually to the Northward and Eastward in the afternoon. From the observations made, no law could be deduced, but the fact was established that a tidal stream attains there a velocity of three-quarters of a knot an hour, when there is no sensible stream a few miles away.

To different currents must be attributed the loss of the sloop *Comus*, the transport *Harpooner*, H.M.S. *Drake*, and the brig *Spence*, all of which were lost, at different times, upon *one spot*, the little bay called *St. Shot's Bay*, on the South coast of Newfoundland, and lying between Cape Freels and St. Mary's Bay. The *Comus* was from the West, and was lost in the night of October 24th, 1816, after having sounded, as supposed, on the inner edge of Green Bank. The *Harpooner*, a transport with troops, was from Quebec, and bound for London; she struck at 9 p.m., November 10th, 1816. The *Drake* sailed from Halifax for St. John's, June 20th, 1822, under very favourable circumstances, upon a direct course for Cape Race; but on the 23rd the weather became thick, and at noon she was supposed to be 90 miles from Cape Race, but at 7^h 30^m p.m. breakers were reported ahead, and the ship was soon after a total wreck. The *Spence* was from Richibucto, in the Gulf of St. Lawrence, with lumber, bound to Liverpool, and was totally lost at St. Shot's, at 4^h p.m., July 16th, 1822. Another vessel, the *George Canning*, from Chaleur Bay to Aberdeen, was wrecked here, during a dense fog, on June 17th, 1829.

The five vessels, it may be seen, were all from the *Westward*, and all, it may be presumed, were set to the *Northward* as well as to the *Westward*, of the situations which they were supposed to occupy, and the route which each intended to pursue. This can be accounted for only by the supposition of currents winding round the coast, opposing each other, and operating as above explained; for it seems clear that the Westerly current from the Grand Bank so opposes the Easterly one as to limit its operation *Eastward*, and give it a Northern inflection; thus producing the indraught into the Southern bays of the island.

It appears that the South-Westerly current, over the Grand Bank, sets over the whole of the Northern part of that bank. In a summer voyage, on September 30th, 1826, in lat. 46° 24′, Lieutenant Hare sounded on the outer edge of the Bank, with thick blowing weather from S.W.; and, on the next day, in 45° 56′ N., 48° 6′ W., had no bottom at 120 fathoms, with a very heavy swell from W.S.W., although he found that a current had carried him S. 67° W., 34 miles. Thus appeared, in close conjunction, a South-Westerly current, with another *from* W.S.W., where the edges of the two entered into collision with each other.

(436.) In August, 1885, Captain Lugar, of the cable-steamer *Mackay Bennett*, states that the current was found running S.S.E., at the rate of three-quarters of a mile an hour, when about 45 miles Eastward of the Flemish Cap, or in lat. 47° 30′ N., long. 44° 4′ W. At 60 miles farther Eastward, in lat. 48° 0′, long. 42° 35′, the current set about N.N.E., 1½ to 2½ miles per hour.

On August 9th, 1885, the cable-ship *Minia*, when in lat. 48° 2′, long. 42° 24′, found the current setting South-Westward, 1 knot per hour; then the surface temperature suddenly rose 11°, and the current turned to N.E., 2 knots per hour. Captain Trott, of the *Minia*, in December, 1884, found the cold current setting strongly along the Southern edge of the Grand Bank. In lat. 43° 10′ N., long. 49° 30′ W., it was observed setting S.W., 2·3 miles per hour, but during the same period no current was found on the bank itself. Eastward of long. 48° 45′ W., a set to the Eastward and N.E. was observed; the change in direction being clearly indicated by a rise in the temperature of the water from 36° to 41° F.

The same vessel, when off the S.E. part of the Grand Bank, between lat. 43° N. and 44° N., and long. 48° and 49½° W., during July and August, 1885, found the currents very irregular in direction and strength; but generally to the South-Westward in December, from 1 to 3 knots. Fairly regular tides were experienced on the edge of the bank during fine weather, and sometimes slight currents from all points of the compass.

(437.) A branch of the Labrador Current usually sets into the Strait of Belle Isle, between the island and the coast of Labrador, transporting immense quantities of Ice in some years into the Gulf of St. Lawrence, if the bergs are not too large to be intercepted by the moderate depth of the strait, although this feature varies very much indeed in different years. This Current has been observed to run 2 miles an hour with the wind from N.E., while at other times it is almost insensible, and it is stated sometimes to run in the opposite direction, especially during the ebb tides with S.W. winds. After it enters the Gulf, it runs 39 or 40 miles farther, when it becomes dispersed and merged into the general streams.

The current which sets out of the Gulf of St. Lawrence, between Newfoundland and Cape Breton Island, also adds its effect to the main branch of the Labrador Current setting to the S.W. It is composed of the stream of fresh water which constantly sets down the river, and the branch of the Labrador Current passing through the Strait of Belle Isle. This outset is very frequently of some considerable strength, especially with Westerly winds or in calm weather. But its strength is reduced, or it is even retarded altogether, with opposing winds, which have a powerful effect on it at all times.

Both these currents are modified by the Tides, but in a way directly contrary; for, while the Strait of Belle Isle current is quickened by the flood, and retarded by the ebb, the other is increased by the ebb, and checked by the flood which enters the Gulf from the Southward. The tidal hour is therefore important in estimating the probable set of these currents, which, however, it may be said to be exceedingly difficult at all times to estimate and allow for correctly.

(438.) *Along the S.E. Coast of Nova Scotia* the currents are irregular, and are said to be one of the principal causes of the frequent wrecks on Sable Island. These currents are rendered inconstant and irregular, both in strength and direction, by local and distant winds; but the general tendency is well known to be to the Westward and South-Westward, at an average rate of about 12 miles a day, for vessels find no difficulty in working to windward in that direction, anywhere to the Northward of the Gulf Stream; and hence it is that many of the vessels wrecked on Sable Island were supposed to have been well to the Eastward of its position when they ran on shore.

Sable Island has been famous for its wrecks, which greater knowledge and consequent caution have rendered less frequent. Its position and formation are remarkable, as it lies apparently in the strength of the Arctic Current. Its dangerous character is greatly increased by the prevalent Fogs, which are dense and very constant. As is well known, it is a mere sandbank, about 21 miles in extent, East and West, consisting of two parallel ridges of sand blown above the sea-level, enclosing a shallow lagoon, and forming a curve convex to the Southward, showing the direction of its principal growth. From each end extend long "bars" or shoals, that to the West for 21 miles, and that to the East 17 miles, the whole extending over an area of 53 miles, E.S.E. and W.N.W., within the 10-fathoms line. The Westerly winds and current, tending in the same direction, are constantly wearing away the West end, and adding to the East, by drifting the sand of which it is formed, and that which it it brings, to leeward. Of the lighthouses established on it since 1880, two have been washed away, and in 1890 the third was being rapidly undermined by the waves; their present positions are given in the Light Book.

The wrecks have usually occurred from the effects of the S.W. current which we are now considering, and which, though irregular in its action, has usually some effect on a ship's course; added to this, as previously shown (408), the Gulf Stream is here found with much diminished force, and consequently there are some anomalies in the immediate neighbourhood of Sable Island. The best account we have of the streams is that given by Mr. Darby, who was superintendent of the establishment here.

Mr. Darby has said, "On the South side of Sable Island, the current, in shoal water, with prevailing South and S.W. winds, sets rapidly Eastward until it reaches the end of the N.E. bar. It then unites and blends with the *St. Lawrence Stream*, which passes the bar in a S.S.W. direction, and runs strongest in April, May, and June. I have sufficient reason for believing that the Gulf Stream, on the parallel of 42° 30′, running E.N.E., occasions the St. Lawrence Stream, then running S.S.W., to glide to Westward. The strength of this stream has never been noticed, and three-fourths of the vessels lost on Sable Island have been supposed to be to the *Eastward* of the island, when, in fact, they were in the longitude of it.

"Easterly, Southerly, and S.S.W. winds set a rapid current along shore in shoal water, to W.N.W. and N.W.; that is, along the shore of the Western end of the island, but not the Eastern nor middle, as there the current, with Southerly and S.W. winds, sets to the Eastward. The natural tendency of the flood-tide is toward the coast. When it strikes the island it flows to the Eastward, over the N.E. Bank, and to the Westward, over the N.W. Bank, and passes the West end in a N.W. direction, so rapidly that it carries the sand with it; and the hills of the West end, being high and narrow, they are undermined at their base by it, and tumble down some thousands of tons of sand at a time. This the current beneath catches, and sweeps away to the N.W., increasing the bank. So soon as the current passes the extreme point of the dry bar, it tends more across the bank to the N.E.; the motion of the sea contributing to keep the sand in motion, the current carries it to the N.E., and spreads to the N.W."

(439.) In following the course of the Arctic Current along the coast of the United States, we have no very clear notion of its mean velocity; it is certainly very feeble. But that it does run to the Southward, we have many evidences, besides the temperature of its waters. It is probable that the surface, at least, is obedient to the varying of the winds, which blow over it, and after a long continuance of Easterly winds it often sets directly on shore. But it preserves its course almost unimpaired and quite appreciable on the surface as far South as Cape Hatteras, after which its presence does not appear so manifest, except as a submarine current. In (398), &c., the presence of the cool water it transports is shown to exist, in a great degree, even close beneath the warmest and strongest parts of the Gulf Stream.

There is great evidence of current action all along the coast of the United States beyond the Cape Cod Peninsula, itself of remarkable formation. The long straight lines of low alluvial shores, fronting extensive shallow lakes, separated from the Ocean by narrow beaches thrown up by the sea, all bespeak the work of the Ocean and its drifting waters.

There is another singular feature, too, in the more Southern portions of its course. The long lines of shoals which project seaward from Capes Hatteras, Fear, Look-out, &c., that is, in the section where its surface action is not so manifest, indicate some process going on which as yet has not been entirely explained.

(440.) Between Cape Henry and Cape Hatteras many vessels have been wrecked, owing, it is stated, to a strong current setting inshore, or to the S.W., from about 6 miles South of Cape Henry to Cape Hatteras. Although the Arctic or Labrador Current sets generally to the Southward, there is reason to assume that near the coast of North Carolina its direction is chiefly governed by the wind. It runs very strong, causing heavy rips, which have every appearance of shoals to those who are not familiar with them. Sometimes the current begins to run quite strong 24 hours in advance of the wind at the same place. The storm, which is almost certain to follow, always sets in from the direction in which the current has started.

The currents, over and in the vicinity of Hatteras Shoals, have a velocity of 3 to 5 knots an hour, and are greatly influenced in direction and force by the winds. The surface water of the Gulf Stream extends to within a short distance of the outer shoals for some time after a continuation of Northerly and Easterly winds.

Vessels, therefore, should approach this coast with much caution, observing that between Cape Henry and the lighthouse on Currituck Beach, a distance of 34 miles, depths of 10 fathoms will be found at from 5 to 15 miles off shore; thence to Cape Hatteras that depth is found at 1 to 4 miles from the shore.

(441.) Commander W. W. Kiddle, R.N., remarks, that to steam-ships crossing the Banks of Newfoundland, this Arctic Current offers a ready means for checking the longitude on the Eastern edge, which should never be lost sight of when the absence of astronomical observations has rendered the position doubtful. The degree of accuracy with which this may be carried out is very remarkable, except occasionally towards the close of summer. The Western edge is not so well marked, owing to the drift from the Gulf of St. Lawrence.

In a similar manner, when approaching *St. George's Shoals* from the South or East, the thermometer will give unfailing warning of their proximity by a sudden fall in the temperature of 2° to 4°.*

(442.) In a nautical sense the allusion to this Current is sufficient to guard against its effects in approaching the coast, or in taking advantage of it to work against the current of the Gulf Stream. Beyond what is stated above, no particular instructions have been issued respecting it.

(443.) There is another part of the Ocean in connection with this where the currents are not strong or regular, but peculiar. It is the part between Bermuda and the coast of Georgia. There seems to be some connection with the fact of Cape Hatteras cutting off a portion of the Southern progress of this Current, and the very irregular temperatures that are met with to the South-Eastward of that cape. The cold bands alluded to on page 405 (395) are, perhaps, a portion of this; but it certainly seems as if the cold water, after passing under the Gulf Stream, appears on the surface intermingled with the warmer waters of the Equatorial Current, and cause a slight drift to the South-Eastward, and have something to do with that Eastward tendency of the Gulf Stream (403) in throwing off its floating objects to the Eastward of its course—a fact which has been attributed to its being "*roof-shaped*," a form owing to the greater force and velocity of its centre, which causes the water along the middle of its course to be higher than the lateral portions.

In the Southern part of this Current its influence on navigation, as said above, is of minor consequence. Its principal feature is its ice-transporting powers in the more Northern portion of its career; and as this has a most important bearing on the navigation between Europe and America, some notes on this point follow.

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* "Notes going West," an interesting article in the Nautical Magazine, August, 1878, page 725.

ICEBERGS, ICE ISLANDS, AND DRIFT ICE IN THE ARCTIC CURRENT.

(444.) Although we have already noticed, in the previous pages, the annual floats of Ice which descend from the Northern regions, it may not be inapposite to recall to the seaman's mind the necessity of guarding against these tremendous and dangerous objects—more dangerous than permanent rocks, because unfixed, and more dreadful, because frequently obscured in snow and fog.

The Ice which is thus met with is of two descriptions; that which is formed on the surface of the sea during the Polar winter—the Field and Floe Ice; and that which is formed in the course probably of many years upon land, and is periodically launched into the sea in the form of gigantic Bergs of enormous height and dimensions.

Many observers have in recent years added to our knowledge of this subject, and the following condensed account is the result of a perusal of their experiences.* As with the Winds and Currents, so with the Ice; no exact limits can be given for its occurrence, as these vary from year to year according to the season.

(445.) **Field Ice.**—A few words only are necessary with regard to this form of Ice, as its production and presence in the regions under consideration is very readily comprehended. It is usually formed near the shore, and on breaking adrift, its motion, more affected by wind than current, causes it to raft and pile until its surface becomes very irregular. It sometimes encloses deeply immersed fragments of Bergs, known as "growlers," which may be recognised by their dark blue colour, and must be carefully avoided by vessels making their way through loose ice. Being less easily seen than Bergs, it may be said to be more formidable to fast vessels. The great danger to vessels attempting to pass through loose Ice, unless specially strengthened, is that a gale may suddenly arise before the vessel can get clear of it, and iron plates easily crack on coming in contact with the heavy pieces. If a ship get fast in the Ice, no time should be lost in provisioning and getting out the boats, in case the vessel be suddenly crushed.

The drift of Field Ice is chiefly determined by the wind, which sometimes causes it to appear or disappear with astonishing rapidity, especially near the land.

On February 12th, 1890, the steamer *Texas* passed a Field about 50 miles long, in lat. 44° N., long. 49° 25′ W. On the 17th, the barque *Meteor* was hemmed in for 9 days among an immense Field South of Cape

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* Much information has been gained from the "Pilot Chart of the North Atlantic Ocean," published monthly by the United States Hydrographic Office, on which the occurrence of Ice is systematically recorded. Among other authorities we may mention, "Information relating to Ice, &c., on the Coast of Iceland," by Lieutenant C. F. Wandel, Danish Royal Navy, 1879; "A Report on the Movements of the Ice, &c., on the Coast of Newfoundland, &c.," by Commander Geo. Robinson, R.N., 1889, with a Supplement, 1891; and a "Report of Ice and Ice Movements in the North Atlantic Ocean," by Ensign H. Rodman, U.S.N., 1890.

Race, and the crew had to abandon her, so much was she damaged, being rescued by a passing steamer. On the 22nd, the steamer *Conscript* cut through more than 100 miles of Field Ice, between 1 and 2 feet thick, when between Miquelon and Cape Breton Island, and stripped the sheathing from her bows.

(446.) Along the coast of *Labrador*, Field Ice begins to form at Cape Chudleigh, on the South side of Hudson Strait, about the middle of October; at Belle Isle, about the beginning of November; and by the middle or end of November the whole coast is usually solidly frozen, the Ice forming an impassable barrier, till about the end of April. The bays frequently remain frozen over until June.

The coasts of *Newfoundland* and the *Gulf of St. Lawrence* are usually blocked with Ice by the middle of January. Navigation in the *River St. Lawrence* closes about the middle of November, and does not reopen till about May, though much Ice may be found in the Gulf up to July.

Commander Robinson states that in December and January, Ice usually forms for 20 to 40 miles, seldom farther, off the Eastern shores of Newfoundland, and fills up the deep indentations of the coast. In some seasons very little Ice is seen on this coast, but in the summer months heavy bodies of Arctic Ice drifting Southward form a constant obstruction between Indian Tickle and the Fogo Islands. The French fishing vessels bound to the harbours of Griguet, Croc, and Fleur de Lys, generally endeavour to make the land about Cape Bauld, where the Ice is often loose and broken about the middle of May. Large vessels should not approach Notre Dame Bay before June 10th or 15th, and then only with the aid of a pilot.

From a record kept at Belle Isle lighthouse between the years 1872 and 1885, the earliest date of steamers being seen entering the *Strait of Belle Isle*, varied from June 7th to July 16th, and the last outward-bound from November 11th to 22nd.

Off *Cape Race* the mass of Ice sometimes extends 60 to 100 miles to the South and S.W., and from 150 to 250 miles to the Eastward. In ordinary seasons it seldom extends in a body South of lat. 46° N., and often remains in the vicinity of Virgin Rocks until the end of April. Ordinary cargo steamers have reached St. John's in March and April by passing through the soft Ice, or rounding its Southern extremity and approaching Cape Race from the S.W. It is only during a continuance of Easterly winds that the Ice forbids access to St. John's.

In *Cabot Strait* the Ice usually begins to flow out early in January in sheets; small Bergs, 10 to 18 ft. high, are sometimes seen, but a large Berg seldom. After leaving the strait, the Ice often drifts as far Southward as Sable Island. The strait may be regarded as closed for ordinary navigation after January 9th; it generally opens between April 25th and May 15th, but some seasons it is later.

(447.) **Icebergs** are a much more interesting subject for discussion, and their majestic proportions at once attract attention and invite enquiry as to their formation; consequently we find many reasons and speculations have been advanced to account for them, and various localities pointed out as their birth-place. As already stated (424, 427—433), these masses of Ice are brought from their Arctic home partly by means of the East Greenland Current, but mainly by the current passing through Davis Strait from Baffin's Bay. Investigation has also shown that by far the larger number have their origin on the Western coast of Greenland, as described hereafter.

Captain (afterwards Dr.) Scoresby, whose opinion is invaluable, observed "that, however dependent the Ice may have been on land, from the time of its first appearance to its gaining an ascendency over the waves of the Ocean, sufficient to resist their utmost ravages, and to arrest the progress of maritime discovery at a distance of, perhaps, from 600 to 1,000 miles from the Pole, it is now evident that the proximity of land is not essential, either for its existence, its formation, or its increase."

Dr. Scoresby's acquaintance with Icebergs in progress of formation was confined to Spitzbergen and portions of Greenland, where they do not form so marked a feature as in some other parts. It is to Dr. Rink, a resident in Greenland, that we are indebted for a very complete account of these marvellous phenomena, and in making a few extracts from his work,* we may draw attention to the parallel condition of the South Pole in producing these Icebergs on a far more stupendous scale than is found in the Northern region; for while in the North their dimensions are usually confined to a few hundred yards, in the South they are very frequently miles in extent, and from 2,000 to 3,000 feet in thickness—a magnitude owing to the vast area of the lands in which they are produced, as explained in (449). Their protrusion into the sea involves the same considerations as the "glacier theory" of the land, so very interesting and important in geological questions.

(448.) **Size, &c.**—Dr. Rink states that the larger Icebergs in the Northern regions rise above the sea to the height of from 100 to 150 feet and upwards, and some are 4,000 feet in circumference. The cubic contents of the part *above* can scarcely be considered more than one-eighth of that *below* the surface of the water, so that the cubic contents of such an Iceberg may amount to about 66,000,000 cubic yards—a fragment of Ice which, if we suppose it to be fairly landed, would form a mountain about 1,000 feet in height. Of course the form of the Iceberg has much to do with the proportion above and below the surface of the sea; one with a towering spire of small dimensions could naturally be as high above the surface as the base is below.

Many instances are on record of Icebergs being met with of far larger dimensions than those given above, and the following are a few of recent occurrence.

On January 5th, 1881, a low level Berg, 15 feet high, and several miles in length, was observed from Cape St. John, Newfoundland.

In April, 1882, the steamer *Hermod* was reported to have passed some Icebergs 1,000 ft. long and 500 ft. high, and stove in her bows against one of them.

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* Dr. H. Rink, "On the Ice of Greenland and the Origin of Icebergs," in the Journal of the Royal Geographical Society, vol. xxiii., pages 145—154.

On April 6th, 1890, an enormous flat-topped Berg, over two miles long, was seen from the steamer *Teutonic.*

On July 18th, 1891, the steamer *Kansas* passed an Iceberg 500 ft. long, with two peaks 800 ft. high.

On May 18th, 1892, the steamer *Hafis* is reported to have passed an Iceberg about 600 ft. high and 4 miles long.

Icebergs such as these would ground on the Grand Banks of Newfoundland, and remain until further dissolved or broken up. Some consider that these banks have been formed by the masses of soil and rock brought by Drift Ice and Bergs during the course of ages.

(449.) All agree that the Icebergs of the Arctic seas are originally formed on *terra firma,* from the snow and rains which, from the severity of the climate, are never able to reach the Ocean in a fluid state, but which, in the course of years, are transformed into a mass of Ice, and are then, through some physical agency, similar to that by which the progress of glaciers is effected, thrust forward into the sea, in the form of massy mountains.* For the formation of Icebergs accordingly a tract of land of a certain extent is necessary, in which the sea forms so few and small creeks or inlets that rivers or watercourses of some magnitude must necessarily be present.

Where the above-mentioned condition exists, in conjunction with the necessary temperature of the climate, the formation of Ice does not proceed from certain mountain heights, but *the whole country is covered with Ice to a certain elevation; mountains and valleys are levelled to a uniform plane; and the river beds are concealed, as well as every vestige of the original form of the country.* A movement, commencing *far inland,* thrusts the outer edge of this mass of Ice forward toward the sea; and when it reaches the frith it may be seen to sink, and to diverge and even extend out several miles. There the agency of the *obliterated rivers* may be observed in the greater or lesser rapidity with which the matter in a solid state is carried forward to the Ocean. The massy crust, *still preserving its continuity,* proceeds from the shore, borne by the sea, until some circumstance or other destroys the equilibrium, and breaks some fragments off the outer edge, which is again thrust forward, and again detaches new fragments, thus continually renewing the supplies from the interior.

A tract or body of land of the requisite size is, in the Northern Hemisphere, only to be found in Greenland, and more especially in that part which lies to the North of the Arctic Circle, where in the interior, beyond the inlets of the sea, the country increases in breadth from East to West, and affords space for the original birth-place of these large Icebergs. Neither Spitzbergen, nor the narrower parts of Greenland, nor the Peninsula, nor the islands which surround it, are adequate in size to produce the yearly excess of indissoluble Ice, which, *from that large and unknown continent, is very slowly protruded.* The friths or fiords, which, piercing far into the country, receive and transmit the Icebergs, are called *Ice Friths.*

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* It is a well known fact that all the Ice formed from snow upon the surface of land, where the heat of summer is incapable of melting and preventing its gradual increase, has a tendency to extend and move downward, as water would do, according to the same laws, in the case of rain instead of snow having fallen upon the surface. Those masses of snow accumulated in high regions of mountain chains, even in the hottest parts of the globe, gather in the valleys, which thus form the natural drainage for the highlands, and being congealed into a compact body of Ice, move slowly down into lower and warmer regions, till the increasing heat, by thawing them, sets a limit to their further spread. These masses of compact Ice spreading down through the valleys or clefts, and constantly furnished with further supplies by the snow accumulated in the surrounding highlands, are, in Europe, seen on the largest scale upon the Alps, where they are known under the name of "Gletscher," or Glaciers.

From November to June the water, in which the Icebergs are to proceed to the Ocean, is so covered by the ocean Ice, that they are shut up in the inner ice friths; but in July, and especially in August, they are carried in mass by the current to the open sea. This is called *the shooting out of the ice friths,* which lasts till late in the autumn, when the continual Easterly storms finally clear out the inner waters, unless the Icebergs are intercepted by certain banks, on which they sometimes remain long aground.

(450.) Icebergs consist mostly of hard, brittle ice, of which the white colour arises from very fine lineal pores, uniformly distributed through the whole mass, all being of the same size, equi-distant, and parallel throughout the whole Iceberg. This uniform structure may have arisen at the time it was formed in the interior of the country from corned snow —perhaps repeatedly thawed and frozen. The white Iceberg is in many directions crossed by broad stripes of intense blue-coloured ice, which is quite clear, and either contains no air bubbles, or, at all events, very irregular ones. These blue stripes are several feet in thickness, and in them are generally found " dirt bands " of foreign matters, such as stone, gravel, and clay, which the Icebergs carry off embodied in them. The *blue* ice is, by thawing, dissolved into regular large grains, which is not the case with the *white* ice that forms the main mass of the Icebergs. It seems probable that these blue stripes are formed by a filling up of the fissures in the *inland* ice with water—perhaps mixed with snow, gravel, and stones; and such a refrigeration of the water in the fissures may be supposed to be an important agency in setting in motion these great mountains of Ice.*

(451.) **Iceland.**—We have previously mentioned the stream of Ice passing down the East Coast of Greenland. In some seasons this has been known to envelop Iceland. Lieutenant Wandel states that around Iceland, at least near Nordland, Bergs may be met with at all seasons of the year, but the great masses of Drift Ice which hinder navigation usually appear between December and April; some years it may be almost absent. As a general rule, the Ice first appears near North Cape, and its drift depends on the winds and currents. Navigation is open near Nordland early in June; the Ice, however, has been known to remain so late as August 23rd.

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* Transparent ice, free from interior spaces or bubbles, is one of the purest substances in nature, and it is not possible to detect the presence of the minutest portion of air, or any substance that may have been held in solution by the water from which it is formed. The strongest poisons, or colouring matter of any description, are most effectually separated from water by the process of freezing it. This must, of course, only be understood to refer to those masses which are quite clear and transparent, for spaces or vacancies left in the ice will naturally contain portions of the adventitious matter. Ice, therefore, is one of the best sources from which a supply of fresh and wholesome water can be obtained, and if these hollows be washed in fresh water, ice water will be found preferable to, and purer than any other.

Lieutenant Wandel is of opinion that the limits of the navigable season, especially for Nordland and Osterland, are April 1st and October 15th. Vessels trying to make Nordland or Osterland in March often have to wait a month for the Ice to move, and are exposed to violent storms. Many vessels have also been lost in the fearful storms of October and November.

The Ice encountered around Iceland comes either from Greenland or Spitzbergen; that from Greenland consists of great level floes over 30 feet thick, and that from Spitzbergen is exclusively in the form of Bergs, which often ground in depths of 60 to 70 fathoms. On September 22nd, 1877, Lieutenant Wandel encountered a Berg off Skagestrand Bay, 66½ ft. high, and at least 2,000 ft. in circumference, while two others were seen stranded.

Mr. T. Thoroddsen's researches show that around Iceland the Drift Ice often appears as early as January, and lasts till autumn; generally there is very little during September, October, November, and December.*

(452.) On the *South Coast of Greenland*, the settlers and others remark that the Polar Ice always appears in May, June, and July, but there is none in November, December, January, and February. Commander Robinson states that in the month of June sealing vessels visit the Ice Southward and Eastward of Cape Farewell, from which it extends 50 to 80 miles to the Southward, moving Westward 8 to 10 miles a day. In February it is noticed 100 to 150 miles Southward from the cape, terminating in a crook or cape.

Rounding Cape Farewell this stream of Ice continues to the Westward and North-Westward, moving 8 to 10 miles a day, part keeping along the coast as far North as Godthaab, when it bears off to the Westward and joins the main stream flowing Southward from Baffin's Bay.

(453.) Icebergs sometimes ground in *Belle Isle Strait*, but those able to pass through drift up the Gulf, and disappear to the Northward of Anticosti; very few pass out again by Cabot Strait. Bergs drifting to the Westward of Cape Race, usually pass between Green Bank and St. Pierre Bank, but they rarely pass to the Westward of St. Pierre.

(454.) **Newfoundland Banks, &c.**—We have thus traced the course of the drift of the Arctic Ice down to the latitudes in which at some seasons it becomes a great source of danger to the Northern Transatlantic navigation. Icebergs owe their drift almost entirely to current, and may sometimes be seen ploughing their way through Field Ice drifting in the opposite direction with the wind (445). Vessels sometimes take advantage of this, by means of an ice-anchor and strong tow-line, to get through these Fields, but care is necessary. Many vessels have been damaged by sunken projecting ledges, or by the Bergs suddenly breaking up or turning over, owing to change in their centre of gravity.

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* "Proceedings of the Royal Geographical Society," October, 1884, page 573.

(455.) Many disastrous collisions have occurred with Icebergs, water-tight bulkheads having alone saved the crippled vessels from foundering. Doubtless the disappearance of several vessels may be laid down to collision with Ice. To add to this danger the regions in which they are likely to be met with is much subject to thick and foggy weather.

(456.) *Precautions.*—There is no *infallible* method known by which the presence of Icebergs may be detected at a distance in thick or foggy weather; though, in addition to extreme vigilance, several aids have been recommended. The safest course is to take a Southerly route, well clear of the probable Ice limit.

Lieutenant Evans, R.N., says, " There is scarcely a doubt but that most of the vessels from the West Indies and America, that have been missing, perished in the same manner as the *Mountstone* (see page 451), Icebergs having been met with some degrees to the Southward of the Banks of Newfoundland in June and July. The commanders of vessels, therefore, who have occasion to pass between the parallels of 35° and 50° N., cannot be too cautious; a look-out man should be placed on the fore-yard during the night, and in foggy or hazy weather also in the day-time. In addition to these, there should be one on each bow; and during a fog the foresail should be hauled up, especially in crossing the Banks, where Icebergs have been met with aground."

The *Ice Blink* is a natural brightness or effulgence, caused by emission of rays of light stored up or otherwise, which frequently renders a Berg visible at some distance, even in the darkest night. At short distances this effulgence may appear like a white cloud, extending over, or nearly over, the vessel's masts. In foggy weather they are seen through the fog by their apparent blackness, if such a term can be applied.

The *Temperature* of the water has also been suggested as a means of detecting the proximity of Ice, but much reliance must not be placed on the use of the Thermometer. Naturally, close to Ice the sea temperature must become lowered, but the distance to which this alteration may extend is entirely problematical, as a little consideration will show. It has been shown that sudden alterations in the surface temperature, experienced in the regions where Ice may be met with, can frequently be explained by the vessel passing from the warm water of the Gulf Stream to the cold water of the Arctic Current, or *vice versa.*

With regard to this, Lieutenant Evans remarks:—Careful attention, too, should be paid to the thermometer, as experience has shown that to be an indicator of Ice. Captain Franklin observes, that the approach to Ice would be evidently pointed out in those parts of the Atlantic where the surface is not continually chilled by the passing and melting of Ice, as in the Arctic Sea; and he strongly recommends a *strict hourly* attention to the *thermometrical state* of the water at the surface, in all parts where ships are exposed to the dangerous concussion of floating Icebergs, as a principal means of security. There would be very little trouble attending such a point of duty; yet, we believe, there are many masters who would not undergo it, but trust to chance the safety of their vessel, their own lives, and those of their crew and passengers. Many have made repeated voyages across the Atlantic without having seen floating Ice, and therefore become incautious. It is to these we would particularly recommend the perusal of this paper. The following extract fully corroborates Captain Franklin's assertion:—"The morning of the 1st of August (says Captain Lyon) was thick and foggy, with rain; at 10 a.m. we discovered, through the haze, our first piece of Ice, a small Berg of about 70 feet; we soon passed this and several others, but saw no *floe* or *brash ice*, although there was every reason to suppose that a *pack* was near, from the sudden smoothness and change of temperature in the water, now at 32°, while the air was at only 34°. Repeated observations of this kind have now brought to a certainty the assertion, that the approach to Ice from an open sea may be ascertained by the sudden change of the thermometer; and acting from past experience, I caused the more active look-out to be kept, on observing it to fall suddenly this morning; yet this change first took place in a very thick fog, and we ran about 10 miles before the Ice was seen."

Captain Weddell recommends that, with a free side-wind, an Iceberg or Ice island should be passed on the windward side; as by this means, the loose ice, which always drifts farthest, is avoided.

Warning of the vicinity of a Berg may often be obtained by means of the *echo* of a steam whistle or any sharp noise. The roaring of the sea at the base of a Berg may sometimes be heard at a considerable distance.*

(457.) **Season.**—Ice generally begins to be a source of danger to Transatlantic navigation during the month of February, and continues until the end of August, though in some seasons it may occur earlier or later than these months. May is the most dangerous month, and October and November are marked by its all but complete absence.

In 1890, the Ice appeared unusually early, and a vast number of enormous Icebergs and Fields were reported. In January its Southern limit was in lat. 45° N., long. 48° 30′ W., about two months in advance of the average. On January 5th, some bergs were seen in lat. 47° N., long. 45° W., and on the 21st, some were passed in lat. 44° N., long. 41° W.

(458.) **Limits.**—These masses of Ice are seldom met with to the *Eastward* of the meridian of 49° W., that is, about 300 miles beyond the limits of the Grand Banks of Newfoundland. Near to the Banks they become more numerous, and in some years the sea appears to be covered with them, and vast numbers of Bergs ground on the Banks.

Mr. W. C. Redfield, to whom the world is so largely indebted for his researches in Meteorology and Physical Geography, published a pamphlet, accompanied by a chart, upon the Ice of the North Atlantic Ocean. In this he considers that the Gulf Stream *passes over* the cold Arctic Current, which transports the deeply immersed Icebergs into and across it. "No impulsion but that of a vast current, setting in a South-Westerly direction, and passing beneath the Gulf Stream, could have carried these immense bodies to their observed positions, on routes which

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* In addition to these precautions, we would call attention to the ingenious system of Signals, devised by Captain W. H. Bates, whereby a vessel may readily communicate to another passing, the existence and locality of Ice which may have been encountered. One hoist of flags, of the International Code, is sufficient for a Signal.

ICE CODE.

ICE FLAG, Blue and White.

Face page 448.

45° 40°

SL	SK	SJ	SH	SG	SF	SD	SC	SB	51°
RL	RK	RJ	RH	RG	RF	RD	RC	RB	50°
QL	QK	QJ	QH	QG	QF	QD	QC	QB	49°
PL	PK	PJ	PH	PG	PF	PD	PC	PB	48°
NL	NK	NJ	NH	NG	NF	ND	NC	NB	47°
ML	MK	MJ	MH	MG	MF	MD	MC	MB	46°
LM	LK	LJ	LH	LG	LF	LD	LC	LB	45°
KM	KL	KJ	KH	KG	KF	KD	KC	KB	44°
JM	JL	JK	JH	JG	JF	JD	JC	JB	43°
HM	HL	HK	HJ	HG	HF	HD	HC	HB	30′
GM	GL	GK	GJ	GH	GF	GD	GC	GB	42°
FM	FL	FK	FJ	FH	FG	FD	FC	FB	30′
DM	DL	DK	DJ	DH	DG	DF	DC	DB	41°
CM	CL	CK	CJ	CH	CG	CF	CD	CB	30′
BM	BL	BK	BJ	BH	BG	BF	BD	BC	

47° 46° 45° 44° 43° 42° 41° 40°

der the *Ice Flag*.

e character of Ice seen, thus :—
d of the hoist.—**Field Ice, or Small Icebergs.**
ergs.

or separated by the Pennant, indicate,
, and are found by the Diagram, thus :—
P—42½° to 43° N. lat., 49° to 50° W. long.

International Nautical Magazine, examples
d latitude of crossing longitude 50° W. ; but
cter, and position, are more likely to be used
utility. **Fog,** however, may be signalled by
Flag.

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cross the Gulf Current, in a region where its average breadth has been found to be about 250 miles." Other observations on this subject have been given in the chapter on the Gulf Stream.

To the *Southward* the extent of the Ice-drift is uncertain, as it depends upon two causes: the one, the force and extent of the Arctic Current from the Northward; and the other, the depth to which the Icebergs are immersed. As before mentioned, there appears to be a perpetual struggle between the opposing forces of the Arctic Current and the Gulf Stream to the Southward of the Banks. The area where these currents meet is nearly always distinguishable by the rips caused by the interlacing of the two streams, but this process is made more apparent during the season of the Ice-drifts by deeply immersed Bergs passing quite into the course of the Gulf Stream, under the influence of which they rapidly disappear. The view now accepted of this phenomenon is that the Gulf Stream partly overruns the cool waters proceeding Southward and South-Westward; and although the Northern edge of the warm waters of the Stream is met with in the summer months over the Southern end of the Newfoundland Banks, or as high as 45° N., yet these Bergs have been found drifting as far South as lat. 39° N., and even to 36° 10′, long. 39° W., or 650 miles South-Westward of the Banks, and beyond the limits of the Gulf Stream. Instances are also on record of their being seen within 60 miles W.N.W. of the island of Corvo.

During a regular season Ice is specially to be met with between lat. 42° and 45° N., long. 47° and 52° W. Its Southern limit varies generally between 40° and 41½° N. From temperature observations it is found that the Arctic Current pushes 2° or 3° farther South, between long. 48° and 50° W., and therefore the extreme Southern limit of Ice will most probably be found between these meridians. To avoid dangerous Ice, vessels therefore, in April, May, and June, should not cross the meridian of 50° W., North of the parallel of 39° 30′ N.

From March to July Icebergs may be encountered on the meridian of 50°, between 40° and 52° N., but occasionally as far Eastward as 39° or 38° W., when their Southern limit will probably be 39° or 38° N. in 45° W. From July to September, Bergs may still be met with as far Eastward as 38° W., near 44° or 45° N., but more to the Westward (say 50° W.) as low as 43° to 41° N.* On June 25th, 1886, at 8 p.m., the captain of the brig *Blanche* sighted a large Iceberg, 20 to 30 ft. high. In the morning it was still near the vessel, in lat. 48° 40′ N., long. 15° 22′ W., and he naturally remarked that he never expected to see an Iceberg so far to the Eastward. This is the farthest point to the Eastward in which we have a record of Ice being met with.

In April, May, and June, 1890, enormous quantities of Ice were seen, as far East as the 35th meridian. One vessel reported 140 Bergs, some 250 ft. high and 1,000 ft. long.

On July 10th, 1890, a small piece of Ice, supposed to be the remainder of a Berg, was seen from the steamer *Slavonia*, in lat. 48° 53′ N., long. 24° 11′ W.

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* Nautical Magazine, July, 1890, page 580.

(459.) It need scarcely be said, that great circumspection is necessary in passing near the regions where these dangers may reasonably be expected. The following instances, selected from many others, may operate as sufficient cautions:—

On June 21st, 1794, in lat. 45° 18′, on the Eastern steep edge of the Grand Bank, in a thick fog, H.M. frigates *Dædalus* and *Ceres* were suddenly involved amidst some very high and dangerous islands of Ice. The weather was so thick that objects were not visible at 50 yards distant. The *Dædalus*, commanded by Sir C. H. Knowles, hauled up and passed close to the stern of a ship that lay stranded upon one of the Ice islands, and sailed to windward of it through a great quantity of Drift Ice, and to leeward of another Ice island. The *Ceres*, Captain Thos. Hamilton, passed in the same track, and saw the wreck a quarter of an hour after the *Dædalus*. The course was East, the wind S.W., the sea very high, as the wind blew hard, the night preceding, from the Southward.

Again, on June 15th, 1810, the *Dædalus*, commanded by Captain Inglefield, with a fleet from Jamaica, in lat. 41° 38′, long. 51° 17′, to the Southward of the Grand Bank, passed two Icebergs, and the next day another; providentially the fog, which had been very dense, cleared up for an hour, and allowed the fleet to clear the dangers.

On August 2nd, 1813, H.M.S. *Bedford*, 74 guns, then bearing the flag of Vice-Admiral Stirling, accompanied by the *Cyane*, Captain Forrest, and *Fawn*, Captain Fellows, with a fleet of 105 sail from Jamaica, at 8 a.m., just as the fog cleared away, fell in with an extensive ridge of Ice, having an Iceberg at each extremity, and about 1 mile in extent, even with the water, over which the seas broke with considerable violence. Had the fog not cleared up as it did, about thirty ships must have struck upon it, as that number were steering directly for this formidable reef, and were within the extent of its sweep. The thermometer was at this time ranging from 63° to 65°, in lat. 45°, long. 44° 30′.

On August 31st, 1816, Captain Gooday, in the ship *Jones*, in lat. 46° 50′, long. 47° 54′, saw an island of Ice, from 1 to 1¼ mile long, and from 50 to 70 feet high. When first seen, it appeared like a white cloud.

In January, 1818, the brig *Anne*, of Poole, W. Dayment, master, left the harbour of Greenspond, Newfoundland, in the morning, and in the evening of the same day got among Ice; proceeded thus about 40 miles, and at daylight next morning was completely beset, and no opening to be seen in any direction from the masthead. In this state the vessel continued for fifteen days, drifting with the Ice about 60 miles S.E. by E., or about 4 miles in every twenty-four hours. The Ice was now become very heavy, high above the surface, and about twenty large Bergs were in sight. With this Ice the vessel drove until she was in 44° 37′ N., and about 300 miles to the South-Eastward of Cape Race, when, on February 17th, she got clear through the only opening that appeared in the horizon from East to S.E., all the rest of the circle forming one compact body of Ice, as far as the eye could reach. The vessel had been shut in for twenty-nine days, in the last fourteen of which she drifted from lat. 46° 57′ to lat. 44° 37′, about 280 miles, or 20 miles a day, S.E. by E., tremendous gales of wind blowing the whole time from the West to the N.W. In the course of this passage the master declared that he saw more than 100 large islands of the solid blue ice, known to traders by the name of *Greenland Ice.*

On January 17th, 1818, the brig *Funchal*, of Greenock, sailed from St. John's, Newfoundland. At about 15 miles to the Westward of this port she fell in with a field of Ice coming down from the Northward, about 8 miles in breadth, and extending to the Northward beyond the reach of sight. Having cleared this, and proceeded Westerly about 250 miles, on the 20th, in lat. 47½°, she encountered a still more extensive field, floating to the Westward, in the midst of which was an immense Iceberg; she cleared this, though not without difficulty, and brought with her a gale of wind, with snow, sleet, and rain, the whole way to Scotland.

On May 6th, 1823, the *Mountstone*, of and from Plymouth, was lost on an Iceberg, on her passage to Newfoundland. The master and crew, with passengers, in all ten persons, took to the boat, without provisions, from which three only of the number were taken by a passing ship, on the 14th of the same month, the remainder having died of hunger!

Our next case is that of the *Ajax*, of Wiscasset, New England, on the passage toward London, March and April, 1826. The following is an extract of a letter from William S. Shaw, the commander, to his owners on the subject. His means of protecting the vessel, under perilous circumstances, are worthy of especial notice.

"On March 12th, at 4 a.m. (sea account), between lat. 42° and 44° N., weather thick and cloudy, with squalls of hail and snow, we ran the brig in between two reefs of Ice, jammed together apparently in a solid mass, the sea being much smoother than usual, which did not alarm us; we knew we were far from land or breakers, until we felt the Ice alongside of us; so soon as we perceived which, we hove-to until daylight, when we found we were surrounded by a solid body of Ice. Around us were thirty Icebergs, about 150 feet high, and nearly the size of Segwine Island. Finding the Ice chafed us badly, we got out fenders. As we had run into the Ice before the wind, it was impossible to get out the same way. At sunrise, discovered a narrow opening to leeward, for which we steered under easy sail, and drove her through. We were now in a bay, about 1¼ mile wide, the reefs on either side, and large cakes of Ice in contact with us.

"The wind still blowing fresh at N.W., we kept her before it about 8 miles, but could not discover an opening to the Southward and Westward; tacked and steered N.E. about 12 miles, it being very difficult to avoid the large cakes of Ice that crowded thickly around us.

"Finding there was no opening in this direction, and that the two reefs extended as far as we could see—that there were numerous large islands of Ice North of us, and an almost innumerable collection of small ones ahead, we concluded, at 10 a.m., to crowd her through the Ice; and having prepared fenders of every kind, such as old junk, spars, cordwood, bales of cotton, and part of one cable, we drifted her into it. We were now in the midst of the Ice in a severe gale, accompanied with a thick snow storm; and had it not been for our precaution, in preparing fenders, the Ice must have soon made a hole through us. At mid-day, old Sol deigned to show his brazen face, and laughed at our comical situation. This circumstance enabled us to take an observation, by which we found ourselves in lat. 44° 30′ N., long. 48° W. (between the Azores and Newfoundland).

"As our fenders were nearly destroyed, we were compelled to cut up more of our cable, wooden fenders not sinking deep enough for the purpose of defence under water. You may judge of the difficulty of *crowding* the brig through by our progress, which was but half a mile an hour, under two reefed topsails and foresail, the wind blowing heavily. At one o'clock p.m. we suspended two bales of cotton under our chains, that they might not be carried away by rolling against the cakes of Ice which we occasionally met, some of which were 100 feet in circumference, and 6 feet thick.

"At one time we were so completely enclosed, that I got out, with part of the crew, and walked on the Ice—a walk that few mariners have probably enjoyed at that distance from land on the Western Atlantic Ocean. At 8^h in the evening, found the surrounding Ice much thinner, and the islands less frequent; handed all sails except the close-reefed main-topsail, which we hove to the mast to keep her from ranging ahead on the islands.

"At daylight, finding ourselves clear from the great body of Ice, though not from the islands, we made sail, and steered E.S.E. and E.N.E. for three days, with a good breeze, and under short sail during the night. It was the opinion of all hands, that we sailed *three hundred miles* before we were clear of the large islands of Ice."

In July and August of the same year, 1826, H.M.S. *Ringdove* was on her passage from New York, and fell in with an immense Iceberg off the Banks of Newfoundland, drifting to the Southward, the magnitude and sudden appearance of which astonished every person on board.

In the month of March, 1828, several vessels arrived at New York, which had fallen in with islands of Ice, in lat. 43° to 44°, long. 47° to 49°. This was considered as unusually early in the season for such dangers to be met with. In this season the brig *Catherine and Hannah*, Captain Lumsden, which afterwards arrived at Cork, picked up, on the 4th of May, in lat. 45° 11′, long. 56° (near Banquereau), a boat belonging to the *Superb*, of and from Bristol, for Quebec, which ran foul of an Iceberg on the 21st of April, that stove her forward. This unfortunate occurrence obliged all hands to take to the pumps, at which they continued without intermission for two days and a night, when a schooner hove in sight; and the captain proceeded in the jolly boat to treat with them to take the crew. While the captain was so engaged, the vessel being quite in a sinking state, the crew left the pumps to get the boats out to leave her. They succeeded in getting out a boat (the one subsequently picked up), and seven men got into her; upon which they unhooked the tackle, slipped from the ship, but could not regain her, and, it coming on thick weather, they could not find the schooner; thus the unfortunate men were left without provisions, water, mast, sail, or anything that would enable them to struggle for existence, save and except two oars. In this state they were buffeted about for eleven days, when they were fallen in with by the *Catharine and Hannah*. Of the seven men only two were alive; and one of these survived only twenty-four hours. It is almost superfluous to say, that the only food which they had taken was the bodies of their deceased companions.

Captain Barclay, of the *Brilliant*, for Leith, from Quebec, which he left on June 5th, 1829, narrowly escaped shipwreck, having fallen in with a heavy body of Ice, about 20 miles East of the entrance to the Strait of Belle Isle, in foggy weather. The vessel got clear on the 19th of June, after being three days and nights amongst it, and being obliged to proceed 1¼° to the Southward.

On May 11th, 1833, between the Outer and Grand Banks of Newfoundland, the brig *Lady of the Lake*, John Grant, master, from Belfast, with 230 passengers, in lat. 46° 50′, long. 47° 10′, fell in with Ice, and while endeavouring to pass between two large pieces, a tongue under water struck the port bow, and stove it entirely in. It is not requisite here to repeat afflicting details; the consequence was, that the brig soon foundered, and only the captain, with fourteen other persons, were ultimately saved.

The barque *Perthshire*, R. Simpson, from Pictou, Nova Scotia, fell in with a field of Ice, in lat. 46° 19′, long. 46° 40′, on June 8th, 1845. It was above 30 miles in extent, and on its North end there was a ship, high and dry on the ice, with the crew on board; but could not render them assistance.

(460.) The following are from Mr. Redfield:—On January 1st, 1844, Captain Burroughs, in the ship *Sully*, met with an Iceberg, in lat. 45° N., long. 48° W. This is earlier in the winter than any other case which we have met with. Captain Burroughs states, that he had met with Ice near this position on February 1st, on a former voyage.

In September, 1822, Captain Couthouy saw an Iceberg aground on the Eastern edge of the Grand Bank, in lat. 43° 18′, long. 48° 30′. Sounding 3 miles inside of it, the depth was found to be 105 fathoms. In August, 1827, the same observer, while crossing the Banks, in lat. 46° 30′, long. 48° W., passed within less than a mile of a large Iceberg, stranded in between 80 and 90 fathoms water. He was so near as to perceive distinctly large fragments of rocks, and quantities of earthy matter embedded in the sides of the Iceberg; and to see from the fore-yard, that the water, for at least a mile round it, was full of mud, stirred up from the bottom by the violent rolling and crushing of the mass.

(461.) A very interesting item in our enumeration of Ice-floes is that of those met with in April, 1851, on which were the wrecks of two ships, which had the appearance of, and from all probabilities were, the ships of the unfortunate Arctic expedition under Sir John Franklin.

The brig *Renovation*, of Shields, Captain E. Coward, bound to Quebec, on April 20th, 1851, when near the East edge of the Bank, in lat. 45° 30′, wind N.E., fresh breeze, clear weather, as much as they could carry fore-topmast studding-sail, fell in with Icebergs, one of which was very large, with field-ice attached, on which there were two three-masted ships, having their masts struck and yards down, and all made snug; to all appearance they had passed the winter together on the ice. Took the spying-glass, and carefully examined them to see if there was any one on board, but could see no one, &c., &c. A further statement says they were apparently two full-rigged ships (one about 500 tons, and the other 350), on an Iceberg, high and dry, the larger one on her beam-ends, &c. Singularly enough, this statement had been published in the "Limerick Chronicle," May 28th, 1851, a year previous to any notice having been taken elsewhere.

In our minds there is no doubt but that these were the ill-fated ships which had been drifted out of Melville Sound and Baffin's Bay, and thus eluded all the elaborate and anxious searches that were made. The incident is a singular one in the history of Arctic Ice.*

(462.) Some particulars of later encounters with Icebergs are given in (448). In addition, the experience of Captain Potter, of the ship *Habitant*, may be recorded. He reports having met a remarkable number of Icebergs in lat 49° 30′ N., long. 45° 20′ W., on May 17th, 1892. When the fog lifted in the morning, the ship seemed to be in a great valley, with peak after peak of ice towering all around amid acres of floating ice-cakes, 6 or 8 feet above the water. Twenty-five Bergs were counted in sight, averaging from 100 to 250 feet high, and for some hours the ship sailed along a narrow passage between them, the ice reflecting all the colours of the rainbow in the bright sunlight. Clear water was not entered until night, when the ship had run 75 miles through the ice.

(463.) Lieutenant J. Steele Park, from whose journal we have given extracts elsewhere, recites the following incident, which will bespeak for itself an inculcatory *caution*:—

"June 29th, 1826.—A light breeze from the Southward, with foggy '*Bank weather*,' as the sailors call it. Steering E. by S. At 8 o'clock this morning it cleared away, and I took altitudes for my chronometer, which made the longitude 49° 42′; and, at the same time, we discovered an island on the starboard beam, 3 or 4 miles off. Shortened sail, hove the ship to, and sent the mate to see what it really was; for, although I had no doubt of its being an Iceberg, yet it certainly looked something like land; and I did not wish to leave it in any kind of uncertainty. The fog, which had cleared away at 8 o'clock, and left a beautiful blue sky, returned suddenly when the boat was about half-way from the ship. The mate, an active, skilful seaman, had a compass with him, and he apprehended no danger, but pushed on for the island, instead of returning, when he saw the fog spreading. Hour after hour passed away, and no appearance of the boat. Night came on, dark as the grave, with a cold, benumbing drizzle, and a fog so dense that we could scarcely see across the deck. My grand object was to keep the ship as near the same spot as possible. All day and night we kept the bell tolling, and fired a great gun occasionally; a tar barrel was also blazing at the main yard-arm, but all was unavailing. I shall never forget the terrors of that night. I reproached myself as the cause of their destruction; and I prayed most earnestly for daylight and clear weather. I thought daylight would never come; but it came at last, and the fog was thicker, if possible, than the day before. The most sanguine now began to despair. About 5 o'clock something was heard, like the blowing of a conch shell, but so faint and indistinct that we thought it was only the echo of the great noise we were making on board. However, it was soon discovered that the sound was coming nearer and nearer; but as no person on board knew they had a shell in the boat, we were still in a sad state of anxiety; for it might, perhaps, be a ship sounding her shell in the fog, as is usual at sea. In a few minutes the splash of oars was heard, and in five minutes more the boat was alongside, with all hands safe and sound, thank God! but cold and hungry enough. The mate tells me he rowed round the Iceberg, which he thinks was about 800 feet in length, 150 feet in breadth, and 40 or 50 feet above the surface of the water. It was melting away rapidly; streams of water were gushing down its sides, and they had only got a few yards from it, on their return, when (to use his own words) 'it took a sally and fell over on its beam-ends.' Our last sight of the Ice, when bearing S.W., 3 or 4 miles, was in lat. 42° 18′, long. 49° 44′."

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* See Journal of the Royal Geographical Society, vol. xxvi., pp. 26—35, "On the Probable Course pursued by Sir John Franklin's Expedition," by *A. G. Findlay*. Notwithstanding that this great mystery was partially cleared up by the expeditions of Dr. Rae and Sir L. M'Clintock, yet no vestige of the ships themselves have been seen by Europeans. That portion, as well as others, is still involved in mystery; and the opinion is still tenable, and maintained by many, that these derelict ships were the *Erebus* and *Terror*.

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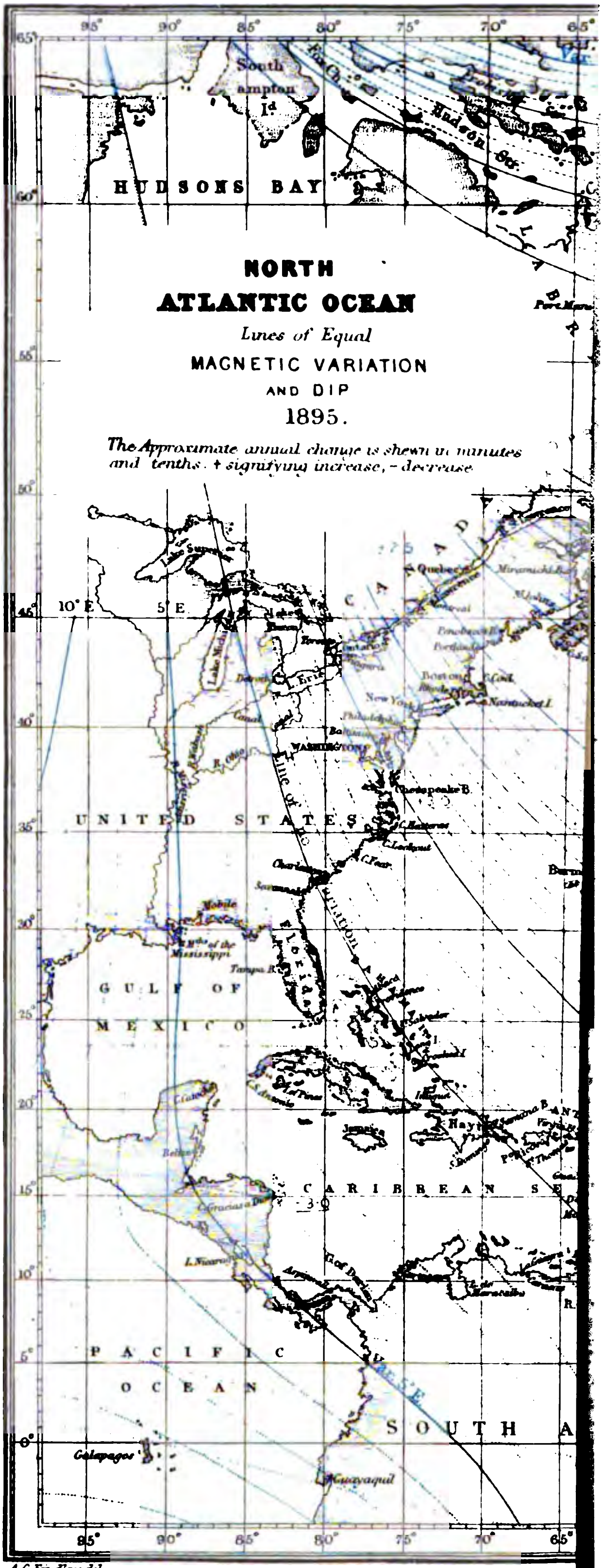

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A G Findlay del.

IV.—MAGNETIC VARIATION.

(464.) Among the many modern changes which have affected the science of navigation, none have been more important than the different relation which the Compass now bears to the ship as compared with its place in former times.

Rude instruments, unadjusted, with errors unsuspected, and under influences destructive to their accuracy, have given place to what may be, in some cases, over-estimation of this primary aid to the seaman. In its very nature the Compass is imperfect and incompetent to show, at sea, the minute quantities which are now disputed over. The consequence is, that it is made, like the topic we have just discussed, Ocean Currents, the scapegoat for many errors of seamanship and judgment, which a more intimate knowledge and therefore greater mistrust and induced caution would have avoided.

(465.) Our present task deals with the *geographic* distribution of Magnetism, not with those local effects caused by the ship or its relation to outer circumstances, but to its position in the Atlantic. The other points, most important in themselves, will be discussed later on.

The features of the earth's Magnetism, as related to the ship, are the *Declination*, *Inclination* or *Dip*, and *Intensity*. The Dip and Intensity are very important elements in the adjustment of the Compass in its passage through the varied magnetic conditions which attend an over-sea voyage across the Equator, but they have but little influence on the directive power of the needle in the latitudes usually traversed in commercial pursuits. The Magnetic Equator does not correspond with the Geographical Equator, any more than the Magnetic Poles do with the Geographical Poles, but crosses it after the manner of the Ecliptic. On the Magnetic Equator the needle has no Dip, but if it be carried towards the North and South Poles, so will the corresponding ends become depressed from the horizontal, till over the Magnetic Poles it would hang vertical.

The *Declination* or *Variation* is one of the most important elements in navigation, and its correct estimation and application most essential to the safe conduct of a ship.

(466.) The reasons why the Compass is now placed in so much higher consideration than it was in former years are manifest. The great increase of the use of iron both for shipbuilding as well as in the fabric of wooden ships, and the consequent vastly increased influence that the ship has upon her Compasses, has been one chief reason why attention is so imperatively demanded. Again, since the universal use of steam, the course of a vessel, in passing directly from one point to another, requires to be much more accurately laid than was thought necessary when wooden sailing ships only were used.

Another reason, which has arisen in the course of years, is that caused by the *Secular Variation*. The Compasses appearing on charts founded on accurate surveys, in the course of a few years, in some cases, are so affected by this change in the Variation as to endanger the safety of a vessel where they have been implicitly trusted to. The appreciation of this change, which became manifest simultaneously with the necessity for improved Compasses and improved methods of using them, placed the magnetic element in charts on a fresh basis.

One most important result of this movement was the appointment by the Admiralty of the late Captain E. J. Johnson as superintendent, in 1842, of the Compass Department. The great improvement in Compasses dates from this appointment, and the investigation of the difficult and varying problems of Local Deviation have been since pursued by eminent men, among whom may be noticed Professor G. B. Airy, Dr. Scoresby, W. Walker, R.N., Archd. Smith, Esq., and many others. These researches have been mainly directed, as before observed, to the effect the ship's iron has on her Compasses.

Captain F. G. Evans, R.N., who succeeded Captain Johnson, drew up a far more perfect chart of the geographic distribution of the Magnetic Variation than had hitherto appeared; former charts having become of impaired value from the lapse of time, and from the imperfection of the observations on which they were based. It is from this chart, brought down to the period of 1895, that the accompanying illustrative chart has been constructed.

(467.) The *Isogonic Lines*, or those upon which the Variation is of the same amount, on this chart, will represent this element, generally as near as the ordinary ship's Compass will show it, and will serve to draw attention to any unsuspected change in the Magnetism of the ship, besides affording the sailor some information when observations cannot be had.

(468.) The *Variation of the Compass* in all parts of the coasts of the North Atlantic Ocean are given with the Tables of Geographic Positions at the commencement of this work. It is for the open ocean that the illustrative chart and these notes are mainly intended, and on the chart is inserted the amount of annual change in different parts, so that the approximate Variation may be ascertained in future years by applying the necessary correction.

Around *Iceland*, the Compass is in many localities unreliable, especially near the shore and over shoals; frequent observations must therefore be made here for ascertaining the error.

(469.) But it must not be supposed that this annual change is regular and of the same amount in each year. By the accurate observations which are now self-recorded, the connection between these changes and apparently remote causes has been identified. One of these, at the first glance a very singular one, is that the spots in the sun, if absent or present in large quantities, have a marked magnetic influence on the Declination, thus demonstrating the source from which the Magnetism of the earth is chiefly derived. As the Greenwich Observations will illustrate our subject as well as any, and this volume might be filled with interesting remarks on this subject, the notices will be limited to the following extracts from those Observations, as being sufficient to impart a notion of the ever-varying amount of the Magnetic Variation and Dip.

TABLE, *showing the Mean Monthly Westerly Declination of the Magnet, and the Mean Dip, at the Greenwich Royal Observatory, from 1844 to 1891.*

Month.	1844	1850	1860	1870	1880	1885
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′	° ′
January	23 19 22	22 28 5	21 14 38	19 57 28	18 34·7	18 4·8
February	23 18 43	22 27 28	21 13 2	19 56 44	18 34·8	18 4·3
March	23 18 42	22 26 54	21 14 53	19 56 21	18 34·1	18 3·7
April	23 18 42	22 25 44	21 15 4	19 55 6	18 33·5	18 3·1
May	23 19 23	22 25 1	21 17 10	19 54 50	18 32·2	18 2.6
June	23 19 8	22 24 47	21 16 1	19 52 52	18 31·8	18 1·9
July	23 18 40	22 23 41	21 15 44	19 52 57	18 32·0	18 1·5
August	23 13 25	22 22 4	21 15 27	19 52 16	18 32·6	18 1·5
September	23 13 6	22 25 43	21 12 44	19 51 55	18 32·8	18 0·5
October	22 12 52	22 19 1	21 13 28	19 51 40	18 32·1	17 59·4
November	22 11 50	22 18 27	21 12 49	19 51 18	18 30·9	17 59·7
December	22 49 41	22 18 27	21 11 30	19 50 26	18 30·7	17 57·4
Means	23 4 28	22 23 47	21 14 22½	19 53 39	18 32·6	18 1·7
Mean Dip	....	68 46·9	68 30·1	67 52·6	67 35·6	67 27·8

Month.	1886	1887	1888	1889	1890	1891
	° ′	° ′	° ′	° ′	° ′	°
January	17 56·3	17 52·0	17 42·7	17 38·0	17 31·7	17 25·8
February	17 55·4	17 51·6	17 42·4	17 36·9	17 31·1	17 24·7
March	17 55·6	17 51·7	17 41·9	17 36·4	17 30·5	17 24·5
April	17 55·2	17 50·7	17 40·9	17 35·3	17 29·6	17 24·8
May	17 54·9	17 50·5	17 40·9	17 34·7	17 28·9	17 24·4
June	17 55·2	17 50·6	17 40·8	17 35·3	17 28·6	17 24·2
July	17 55·4	17 49·5	17 40·5	17 34·0	17 27·4	17 23·3
August	17 54·2	17 48·9	17 39·4	17 33·9	17 27·9	17 23·1
September	17 54·0	17 47·4	17 39·3	17 34·8	17 27·7	17 22·2
October	17 53·0	17 47·1	17 39·5	17 33·4	17 27·2	17 21·8
November	17 52·8	17 44·6	17 38·3	17 32·7	17 26·3	17 21·2
December	17 52·5	17 44·1	17 37·8	17 33·4	17 26·2	17 20·5
Means	17 54·5	17 49·1	17 40·4	17 34·9	17 28·6	17 23·4
Mean Dip	67 27·0	67 26·4	67 25·4	67 24·1	67 22·9	67 21·4

(470.) Upon examining these columns of figures, it will be seen that the decreasing amount of Westerly Variation is far from being regular, and that at some periods the Variation is absolutely *increasing*. The mean Variation in 1891 was about 17° 23·4′, so that it had decreased 5° 41′ in the forty-seven years elapsed since 1844, or at the rate of 7¼′ per annum; but its mean rate at Greenwich is about 5½′ or 6′ at present, according to the most recent observations at the Greenwich Observatory, varying irregularly from 5′ to 8½′ between successive years.

The needle also varies very considerably at times in the course of the day, this diurnal change amounting to 7′, 8′, 9′, and 10′; the maximum Westerly Declination is at 2 p.m. This topic is so large and comprehensive, that if further information be required beyond that given here, and in the Section on Magnetism and the Compass at the end of this work, reference must be made to other works devoted entirely to the subject.

(471.) *Magnetic Storms.*—The daily oscillation in the Variation, or magnetic declination, of the Compass, is too small, even in so-called "Magnetic Storms," to be of any importance in practical navigation.

From the 13th to the 18th of May, 1891, a Magnetic Storm was observed at the Naval Observatory, Washington, U.S., during which the needle varied 48′ in direction in 9½ hours, the North end being drawn 35′ to the Eastward of its normal direction.

During another such storm, February 13th to 14th, 1892, at the same Observatory, the needle oscillated on each side of the mean position, registering a change of direction of 1° towards the East, and nearly 30′ towards the West. This unusually severe Magnetic Storm is of especial interest, as it occurred at the time of the appearance of a large group of sun-spots, and of fine displays of aurora.

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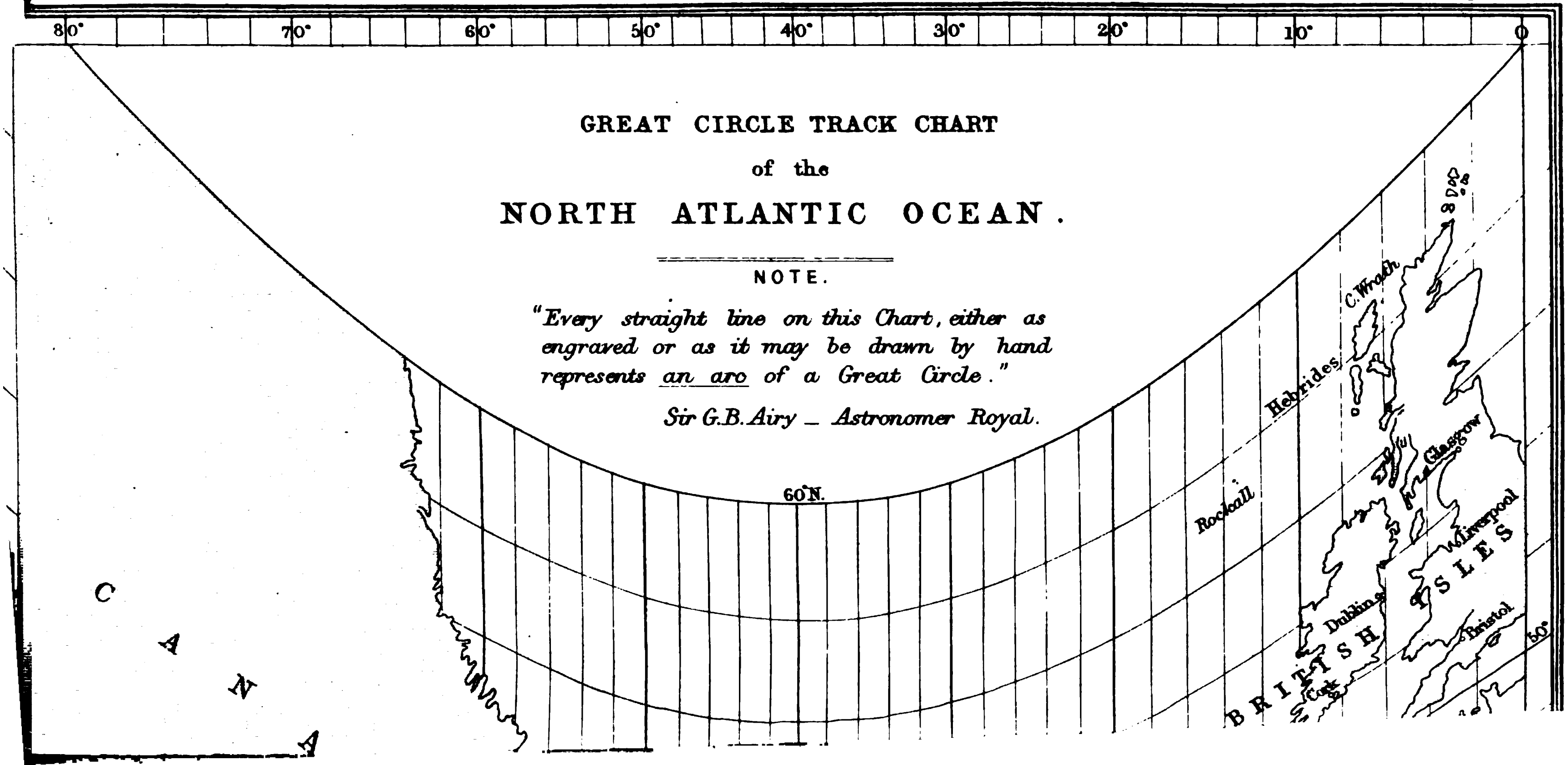

GREAT CIRCLE TRACK CHART
of the
NORTH ATLANTIC OCEAN.

NOTE.

"Every straight line on this Chart, either as engraved or as it may be drawn by hand represents an arc of a Great Circle."

Sir G.B. Airy – Astronomer Royal.

V.—OF PASSAGES OVER THE NORTH ATLANTIC OCEAN.

1. GENERAL REMARKS.

(472.) In the preceding pages we have described those natural phenomena of Winds, Currents, &c., which govern the track of a ship across the Ocean. The object of the present section is to apply these principles to the seaman's practice; but, previous to entering upon this portion of the task, we will make a few general observations upon *Great Circle Sailing*, which has been revived as a new subject, when in fact it is one which was among the earliest principles recognized in navigation. This is not the place to enter into disquisitions on the working of Great Circle problems—that must be left to works specially devoted to Nautical Mathematics.* The excellent "Practice of Navigation" by Lieutenant Raper, or Towson's "Tables to Facilitate the practice of Great Circle Sailing," will be found excellent guides; but still a greater simplicity in the application to ordinary purposes of navigation is a great desideratum.

Great Circle Sailing was known and acted on very early in the history of navigation. It is more than probable that Cabot, Columbus, Magalhaens, and all the first great navigators were acquainted with the subject;† but this, it must be remembered, was prior to the knowledge of the principles of finding the longitude. When Gerhard Mercator, in 1569, published a universal map, on the projection now known by his name, a new era commenced in navigation; but its true principles were first correctly described by Edward Wright, in 1599. In this projection, the meridians being straight lines parallel to each other, the latitude is distorted and decreased in proportion as these meridians are more distant from each other than the correct difference of longitude would give for that latitude. Consequently, a straight line drawn between any two points on such a plain chart, will give the correct compass bearing, which, if maintained throughout the course by a ship, will lead her from one point to the other. This course is well known as the *rhumb course*, and is that in universal use from its simplicity. But it is *not the shortest course*, except it be due East or West on the Equator, or North or South on a meridian, which are Great Circles. This course, developed on a sphere, is found to be a *spiral*, and is considerably removed from a Great Circle, or shortest distance, if a great extent of longitude is traversed by it. We need not pursue this subject, but an example will explain its application.

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* A very complete account of the different methods is given by Mr. G. W. Littlehales, in his illustrated pamphlet "The Development of Great Circle Sailing," published by the United States Hydrographic Office, 1889.

† It is alluded to directly in a work by Pedro Nuñez, in 1537; again, by Pedro de Medina, in 1545, but his system was erroneous, and was corrected by Martine Cortes (or Curtis), whose work, "The Arte of Navigation," was soon after, in 1561, translated out of the Spanish into English, by Richard Eden, and was long the text-book of English seamen. Numerous other works, in which it is correctly and distinctly described, afterwards appeared, as one by Michael Coignet, of Antwerp, in 1581; an excellent work by Roderick Zamarano, in 1585, &c. That by this time it was thoroughly recognized is evident by John Davis's book, published in August, 1594, called the "Seaman's Secrets; wherein is Taught the *Three* Kinds of Sayling—Horizontall, Paradoxall, and *Sayling upon a Great Circle.*" It is also described in Richard Polter's "Pathway to Perfect Sayling," about the same time. After this it is found in most of the old works on Navigation.

From a position off the Land's End, in lat. 50° N., long. 5° 30′ W., to Cape St. John, in the Bay of Notre Dame, in Newfoundland, also in lat. 50° N., and long. 55° 30′ W., the course, *true*, is of course *West*, and the distance on this parallel is 1,928½ miles. But if a ship were to quit the Lizard on a *N.* 70° 20′ 30″ *W.* (*true*) course, and then, gradually bearing more Westward, attain the latitude of 50° 45′ N., in long. 30° 30′ W., thence bearing more Southward, and approaching Cape St. John on a similar angle to the parallel that she had left the Land's End, she will have sailed 1,893 miles, or 35½ miles less than on the parallel; but, in her greatest separation, she will have been 165 miles distant from the rhumb course. Therefore, if she were to take any course between this Great Circle course and the parallel of 50°, she would have a less distance to traverse; and this is the great advantage which the Great Circle Sailing offers—that of a wide range of choice (in a higher latitude) without increasing the distance.

Further, if she were to assume a course as much higher in latitude as the Great Circle course is above the rhumb, she will find that it will be of the same length as the latter. Thus, in the example cited, if on leaving the Land's End she bear away for a point in lat. 55° 30′ N., longitude 30° 30′ W., and then approach Cape St. John, such a curve will be found to be exactly 1,928½ miles in length, and yet be, in its maximum separation, 330 miles apart from the parallel. The advantage of such a range of choice will appear subsequently in the remarks upon the Transatlantic Passages.

(473.) The great difficulties in the application of the principle of Great Circle Sailing to practice were, the laborious nature of the calculations, now, however, much reduced, and the inference as to how a course so much at variance with that which the chart will apparently dictate as the most direct, will place a ship in respect to favourable Winds or Currents. Still, the scope it allows to the navigator must be considered as no mean advantage, even if its shorter distance may not be an inducement to rigorously follow out its principles.

(474.) In the following general sailing directions, the application of the facts in physical geography which have been described in the preceding sections of this work, must be left to the discretion of the commander in most cases. In fine weather, and with fair winds, the estimation of the various influences which affect the ship's course is not difficult to make. But it is the *adverse* circumstances of a voyage that call for the seaman's skill and intelligence, and what has been said will help him to form a judgment of what is going on and how best to proceed.

There is an infinite variety of circumstances which render it impossible to lay down any fixed rule which may be implicitly followed to advantage at all times. Therefore, in cases where a definite course is pointed out as the best to be pursued, and a vessel should be driven out of her intended route, it does not follow that it is right to endeavour to regain that course to pursue it afresh, but rather it should be considered that a fresh voyage has to be commenced, and the course shaped from the latest point as if it were a starting point.

(475.) A vessel under steam only is considered in the light of a sailing vessel with a fair wind. In a certain sense this is true, as it enables her to be independent of Wind or Current. But it should be remembered that the same contrarieties which affect and hinder a sailing vessel from pursuing a direct course, will also, in a degree, be adverse to the progress of a steamer; and, therefore, if a moderate deviation from the shortest route will lead her into more favourable Winds or Currents, that course will be most advantageous to the vessel under steam as it is to the sailing ship.

There is one circumstance which may be mentioned respecting a ship under steam, as to how she is affected by the direction and strength of the wind. If a vessel be steaming before a fresh breeze, strength No. 8, at the rate of 12 or 13 knots, she will experience a perfect calm, while the sailing vessel will only be able to carry her top-gallant sails and royals. If she steams in the teeth of the wind, she will seem to have a strong gale, under which a sailing ship could only carry close-reefed topsails. This will be made apparent by consulting the Tables of the Velocity of the Wind on pages 105—106. Now, a vessel steaming with the wind otherwise than directly fore or aft, will not feel the wind in its true direction; for it will appear to blow from that direction and with that force which is a combination of the rate and direction of the ship's course with that of the velocity and direction of the wind itself. Its apparent and real course and velocity may be found by constructing a parallelogram of forces—a well-known problem. It is for this reason that the wind as registered on board a steam-vessel does not give the correct bearing of its course, and it is much more disguised than it is in a sailing ship when close-hauled, as alluded to in (14), on page 103.

As the steam-vessel, then, may be considered in a great measure independent of Wind and Current, the great object of the past and succeeding remarks is mainly applicable to sailing vessels.

(476.) It has been well observed that the Wind systems of our globe naturally govern the tracks of ships crossing the Oceans, the Trade Winds carrying them from East to West within the Tropics, while the Anti-Trade or Passage Winds will bring them back again Eastward beyond the Tropics. If it were not for the intervening Belt of Calms, sailing directions for vessels going into opposite hemispheres would be of the simplest kind; but the well-known Equatorial embarrassments—" the Doldrums " —generally make a very different matter of it, and cause many considerations to enter into the problem of shaping a course. In the North Atlantic, the obstacles of the intervening Calms seem to be at their maximum, and in the future remarks one chief point, now still argued, will be found to be that which has engaged attention almost ever since over-sea voyages commenced—where is the best place to avoid these Calms and contrarieties of the Equator.

The directions which follow will commence with our own country, although very briefly; for it is presumed that almost every one who will use this book is either well qualified to navigate our own channels, or has more extended works on this point to guide him.

And even in the remarks on more distant voyages very brief notices would generally suffice, for most are now familiar with the varied particulars of the hydrography of the Atlantic as it affects a ship's passage. Notwithstanding the vast labour that has been bestowed on the research into its phenomena, it does not seem that a corresponding advantage has accrued to shipping; for in many cases the directions of a century since will be found as useful as those based upon these refined inquiries. However, one thing may be averred, that passages are now made with much greater certainty than formerly, and even if the average duration of a voyage is shortened a few hours, very much has been gained; and, by the comparison of a great number of voyages made under different circumstances, it may be safely pronounced which is the best course to pursue, and what the average length of such a voyage will be.

For much of the information given on the accompanying diagrams we are indebted to the United States Pilot Chart, which is constructed from numerous authorities, and the sailing tracks are based upon the varying limits of the Winds and Currents, according to the seasons. They must not be considered as infallible, but are given as a guide, on which the mariner may use his own judgment.

2. TO AND FROM THE ENGLISH CHANNEL.

OUTWARD.

For vessels leaving the Downs, and having rounded the South Foreland at about 1 mile distant, the track is W.S.W. (mag.), 21 miles, to a similar position off Dungeness, the depth 13 to 17 fathoms. From a mile off Dungeness to abreast the Royal Sovereign Shoal Lightvessel, the course is W. by S., 24 miles, and in depths varying from 17 to 9 and 12 fathoms. In working down, and while to the Eastward of Folkestone, stand in to 13 fathoms, and off towards the Varne to 16 fathoms.. The dangerous character of this bank has been modified by the placing of a buoy and lightvessel to mark it. Between Dungeness and Bexhill keep outside of 9 or 10 fathoms, and within 25 fathoms. To the Westward keep South of the Royal Sovereign Lightvessel, which will keep you clear of the shoals.

Having arrived at a position 4 miles South of Beachy Head, a course may be shaped down Channel. This course will necessarily be much controlled by the wind and tide; but under any circumstances the English coast should not be left. If the wind be contrary, the best position with the commencement of the ebb is inshore. The flood tide, especially at its commencement, tends to the Southward, filling the large indentations of the French coasts before it sets up the Channel, and then it sets on to the coast South of Boulogne. It is well to remember that the tidal streams throughout the fairway of the English Channel set towards Dover while the tide is rising there, and away from it while falling, so that the Dover tide table answers for the whole distance between the Lizard and Beachy Head. It is high water at Dover, on full and change, at 11h. 12m. All this is explained on pages 285-286.

If the wind is favourable a W. ¾ N. course for 59 miles brings you to a position 4 miles off St. Catherine's Point; from thence W. ½ N., 92 miles, to 4 miles off the Start. In working down do not come nearer the Owers than in 20 fathoms, and to St. Catherine's than 22 fathoms. From thence to St. Alban's Head into not less than 22 fathoms, to avoid the indraught. Between Portland Bill and the Start, if the weather be clear and favourable, you may stand into Lyme Bay to 17 or 16 fathoms. Throughout all this course keep off until in from 35 to 36 fathoms. From off the Start to a similar position off the Lizard, the course and distance are W. ⅜ N., 64 miles, which course continued for 49 miles farther brings the ship 12 miles South of the Bishop light.

Throughout the course as far as off Plymouth, the tides set fair up and down; Westward of this they revolve in all directions, and must be most carefully attended to, as it is also most necessary when to the East of Beachy Head.

In case of bad weather or contrary winds, and necessity for shelter, the following places may be safely sought for. With the winds broad Easterly or Westerly, ships may stop on either side of Dungeness, in East or West Bays, and also on either side of Beachy Head, in Seaford Road, Westward and Eastward of the shoals on the other side, and near Bexhill; and with Westerly winds the Park inside the Owers Lightvessel is also used. Within the Isle of Wight there is anchorage sheltered from all winds. Westward of the Wight, Studland Bay (near Poole) affords good shelter from Westerly gales. The Refuge Harbour in Portland Roadstead affords security against nearly all winds. Good anchorage is also found against Southerly winds in Torbay, Plymouth Sound, and Falmouth.

Most sailors have had some experience of the detention caused by contrary winds in the English Channel. Some of the more remarkable of these detentions have long lived in remembrance. Thus, the Right Hon. Maurice Fitzgerald, in some evidence respecting the Western Harbours of Ireland, gave a curious illustration of the difficulties in making way against these Westerly gales. An officer of considerable experience commanded a small vessel of war belonging to the Cork squadron, when information was received that a smuggler was to land on the Western coast, and he was ordered to cruise off the Skelligs to intercept her. He sailed from Cork, but was brought up six different times at Crookhaven, and, being extremely anxious to reach the ground upon which he was to cruise, he determined to sail round the North of Ireland, and he did so, and reached the Skellig in a very few days.

The detention of Rear-Admiral Christian was proverbially known. He sailed from Portsmouth with an expedition for the West Indies on November 16th, 1779, and, after having been repeatedly blown back, he did not ultimately clear the Channel till the end of the following March.

It seems that the wind generally draws up and down the Channel more or less, and does not blow true as in the open ocean. Thus, a Westerly wind in the offing may become a W.N.W. wind in the English Channel, and a N.W. wind in the St. George's Channel; and the same with the Easterly winds. By referring to (135) to (139), pages 203—205, and the illustrative diagram, the reader will see some exemplification of this in the case of Liverpool, and in (141), pages 206-207, those of the English Channel are discussed, where it will be seen that the Western predominate over the Eastern quarters as 229 to 132. The reason for the prevalence of these Westerly winds, will be found discussed in (128), page 199.

Some statistics are given in (134), page 203, of the observations for 49 years at Greenwich Royal Observatory, and as a further illustration of the direction of the wind in the upper part of the Channel, we may adduce the result of 10 years observations made by the Royal Society at their premises in London. It was found that the mean for the 10 years was 101 days of Easterly Winds against 186 of Westerly Winds; or, supposing a feather to have been abandoned at the beginning of each of the years, the mean direction and number of days, for the 10 years, the feather would have advanced, was N. 85° E. 66 days per annum. This shows how far the Westerly predominate over the Easterly directions. North-Easterly winds are at a maximum in May and June.

HOMEWARD.*

The Bristol Channel I consider safer to approach than either the English or St. George's Channels. The parallel of Trevose Head, on which stands a lighthouse, has been generally recommended, and that of Lundy Island, with its lighthouse, may be used according to circumstances, direction of the wind, &c. In thick or dark weather, the soundings will indicate when you have passed a line cutting Scilly and St. Ann's lights near Milford Haven, and also on nearing the shores on either side. The South side of Lundy is preferred, as you can go safely round it, taking care to keep the light in sight above the land; and as there are generally pilots lying under the island, you are sure not to miss them in pursuing this route.

For approaching and proceeding up the Bristol Channel, various directions have been given. 1st. *Soundings*.—The great difficulty is that the soundings are very deep, and the same water may be got in different positions, both in latitude and longitude, so that a false position by dead-reckoning in the longitude, or in the latitude by the want of observations, is almost as likely to be confirmed as detected; I mean by *detached casts of the lead.* As a precaution against this, I would advise ships (particularly those navigating by dead-reckoning) to "seek the ground early," so that by striking the edge of the bank they may obtain, as it were, a departure, and then take frequent casts of the lead, and make with them a Table in the following form, noting the true course and distance between each two casts, and carefully observing the quality of the ground as well as the depth of the water :—

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* "General Notes on the Approaches to the Channels, and for Navigating the English Channel," by Captain Richard Leighton.

True Course.	Distance.	Depth.	Quality of the Ground.

And where a few of these are obtained and set off upon the chart, one will check the other. Ships, as well as steamers, have been lost by not "*stopping to sound*" (though this difficulty has now been surmounted to a great extent by improved and special sounding apparatus).

The prevalent winds are considered to be S.W. and Westerly from May to December, both inclusive, and from January to April, both inclusive; although long and heavy S.W. and Westerly gales may occur at this latter season, yet they are more frequently interrupted by Northerly and N.E. winds, particularly in February and March. N.W. winds are considered to be generally of short duration.

To approach and pass Scilly, the parallel of 49° 15′ to 49° 25′ has generally been recommended; in place of which I would recommend that from 49° 30′ to 49° 40′, according to the wind, &c., as likely be attended with greater safety; and if the Bishop Rock or Scilly * be not made, having taken every precaution to ascertain the longitude, once that its meridian is past, strike for the Lizard, and if possible, make it, and thence proceed by the rules of the best coasters. Lights can usually be seen when celestial observations cannot be made; and as the navigation is generally free from outlying dangers, courses should be shaped from one prominent point or light to the next, keeping at a moderate distance to ensure seeing them, if possible. The ships generally met with in this route are coasters, and they keep a good look-out, and are generally very anxious to get out of the way of large foreign-going ships.

Easterly Winds in the Winter and Spring Months.—Those winds are very destructive upon the East coast, and often cause heavy losses and great detention among the shipping; and, although they may blow long and steady in all the Channel, yet at times they do not extend to the Westward of Cork, but more generally cease about the edge of soundings; I have known them to blow long and remarkably steady in the Bristol Channel, and yet ships were arriving at Cork with heavy *S.W.* winds.

Whilst speaking of soundings and Channel navigation, I want to strongly urge the use of Captain Sumner's method, as by it a single altitude giving the line AA, with a cast of the lead, or a bearing of the land, will often fix a ship's position with certainty, and its many uses and advantages will soon suggest themselves after a little practice.

My reasons for dissenting from choosing the parallel of 49° 15′ to 49° 25′ to approach the Channel, are :—

1st. A ship in this parallel will pass from 30 to 40 miles to the Southward of Scilly, and will not expect to see it. I think that this precaution attaches too much importance to Major Rennell's Thwart-Channel

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* In thick weather, vessels are recommended not to approach the Scilly Islands within the depth of 60 fathoms.

Current, which I do not consider to be a definite current, but only at times, occasioned by a combination of circumstances driving a great excess of water into the Bay of Biscay, and the excess of *tide* to the Northward does not require so great an allowance.

2nd. That parallel is the centre of the dangerous group of Guernsey, Jersey, the Caskets, &c., which, I believe, have caused more wrecks to ships bound up the English Channel than getting to the "*Northward of Scilly*" has done, and the Channel course trends to the Northward; the difference of longitude between Scilly and the Caskets may appear great, but great errors occur in dead reckoning, and a ship goes far in a winter night with a Westerly gale.

3rd. That parallel has led to or encouraged the imprudent and dangerous practice of galloping up in mid-channel, with neither anchor nor cable clear, and trusting to celestial observations and chronometers, as though it were in the middle of the Atlantic; and here we have the *Conqueror*, *Reliance* &c., sad examples of the effects of not making and keeping hold of the English coast, lights, &c. A great deal was said and written about those cases, but I consider that the amount of error in the course and distance from a position off Scilly or the Lizard, to place a ship on shore between Boulogne and Calais, instead of being in a position off Dungeness, to be an *every-day occurrence* in navigating such a distance in tideways and blowing weather, without any check to correct the account, and neither "storm-waves" nor "storm-currents" were required to cause them.

4th. Foreign-going masters generally keep at too great a distance from the land, by which they not only frequently miss a sight of lights, &c., which it is important that they should see, but they lose the benefit of some degree of familiarity with the land, objects, &c., which a nearer approach would give them, and which, in the event of having to go into roadsteads, &c., would be found of very great service.

5th. It is not by keeping near the land that ships get embayed and lost. If it were, colliers would never be safe; they are as much afraid of getting off the land as foreign-going masters generally are of coming near it. The general rule in coasting is to see every guide as you pass it (unless thick weather should prevent it, and in that case strict attention to the lead until you find the next); this rule and attention to the set and duration of the tides are the grand points in coasting.—*R. L.*

In 1889 and 1890, the officers of H.M.S. *Research* re-sounded the approaches to the English, Bristol, and St. George's Channels, Westward of Scilly, and found considerable variations from what was shown on the chart. It was found that, Westward of Scilly, the bottom consists of a series of ridges, of no great breadth, lying in a N.E. and S.W. direction. The bottom is sand, broken shell, patches of pebbles, gravel, and occasionally mud. Southward of the parallel of 49° 30′, much yellow sand was found, and Northward of that line mixed with black specks; this peculiarity was especially remarked between the meridians of 9° 40′ and 7° 30′ W.

During March, April, and May, sailing vessels are often delayed in the English Channel by persistent Easterly winds, accompanying an area of high barometer over the British Isles. To the Northward of this area of high barometer there are correspondingly persistent Westerly winds, and it therefore follows that under such circumstances sailing vessels, bound for ports in the North Sea and the Baltic, can, with great advantage, take a route to the North of Scotland. On this route, too, there is plenty of sea room, and little or no danger of collision. Favourable conditions for taking this route can be readily determined in mid-ocean, and if Easterly or Southerly winds are encountered to Eastward of the 40th meridian, with a high and steady barometer, there should be no hesitation in shaping a course to the North of Scotland, instead of attempting to take the usual route by way of the Channel, where Easterly winds are then likely to prevail.*

3.—TO AND FROM THE ST. GEORGE'S CHANNEL.†

"Many shipmasters have been bewildered in St. George's Channel, especially in thick weather, from ignorance of the tides and want of experience; some, we are sorry to add, from want of due consideration; and others from not allowing for the indraught into the bays on the Welsh coast (in which the two lightvessels are placed to remove some of this latter danger).

"The writer of the following hints and observations begs to be understood as laying no claim to merit in their compilation; his only motive being to assist and advise the *stranger*, and those who, from want of experience, have acquired only a slight knowledge of this dangerous navigation."

Special caution as to the effects of the Tides seems necessary to be inculcated of late. Some most lamentable shipwrecks have recently occurred on the banks off the S.E. coast of Ireland, by vessels leaving Liverpool under what ought to have been favourable circumstances. The unthinking hardihood of the commander who will place his ship's keel on a special course as if it were a groove, which, if most accurately kept, will just shave clear of destruction, and without taking into account the numerous causes which will horse him off his course, such as bad steerage, leeway, heave of the sea, and, above all, the *set of the tides*—cannot be too strongly deprecated. And yet, as above said, some losses have occurred which have most certainly arisen from a culpable neglect of all these particulars, and been attributed to *charts* or local magnetic attraction unadjusted, or, indeed, anything but the real cause—the thoughtlessness of the sailor. On pages 288—289 are some brief remarks on the Tidal Streams of the St. George's Channel, which will do to remind the sailor of what is said in more extended works.

Another point of caution most important is, the character of the Lights marking its dangers. In Findlay's "Lighthouses of the World and Coast Fog Signals," their latest condition is given, and it is now sincerely to be hoped that no misleading alterations will take place, *without due notice being given beforehand*. The lights, as they were, or as they are, answer their purpose well; but unknown alterations must lead to confusion, doubt, and danger, and have before now been the cause of shipwreck. Therefore, let the seaman who has been absent, perhaps for years, enter these difficult channels with all caution.

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* United States Pilot Chart of the North Atlantic Ocean, May, 1888.

† "General Instructions and Admonitions for Sailing Vessels bound from Liverpool and other Western Ports to the Atlantic Ocean, and for Returning from the Ocean to the same," by Captain Thomas Midgley, of Liverpool.

Captain Midgley's instructions are arranged as follows:—

(*a*) On proceeding from Liverpool Westward to the Bay of Holyhead.
(*b*) On taking the North Channel, and thence to Tory Island.
(*c*) On proceeding by the South Channel, and thence Westward to the Ocean.
(*d*) On proceeding by the South of Ireland from the Ocean to Liverpool, &c.

The courses and bearings (corrected) are to be understood as by compass.

(*a*) ON PROCEEDING FROM LIVERPOOL WESTWARD TO HOLYHEAD.

Liverpool being the principal and central port in St. George's Channel, and the prevalent winds being from the Westward, W.S.W., and S.W., during eight or nine months of the year, I shall suppose that a large ship leaves that port, with an adverse wind from the Westward. Having discharged the pilot off the lightship, stand to the Northward all the ebb tide (which, in Liverpool Bay, sets to the N.W., and the flood to the S.E.), and, if laying N.N.W., or to the Westward of this direction, during the first quarter of the flood, keep the lead occasionally going, with a careful look-out for the Isle of Man, which is moderately high, and on the South side bold-to.

Should there be a strong breeze and a heavy sea, the vessel may not weather the West Hoyle Sands, on the starboard tack; and great caution is, therefore, required when going near them, as they are bold-to and very dangerous. In thick weather the lead must be constantly used, and the sands should not be approached nearer than in 10 fathoms of water.

The soundings along the North coast of Wales, Eastward of Point Lynas, will pretty accurately determine the distance of the ship from the land, provided due attention be paid to the *depth* of water; but the *quality* of the soundings will not indicate the particular part of the coast she may be abreast of.

The *Ormes Heads* are very bold, and the Great Head marked by a fine light, and any vessel may safely steer a direct course from thence to *Point Lynas*, which may be known by the castellated building near its extremity, used as a lighthouse, and the telegraph station upon its summit. Point Lynas and the land to the Westward of it is very bold, but the ebb tide hence runs very strongly to the W.N.W. and through the sound inside the Skerries. Off the Middle and West Mouse the spring ebbs run at the rate of 7 knots; and all vessels should, consequently, give this part of the land a good berth, during light winds, at such times as the flood or ebb may be running strong; or they may, upon an ebb tide, get into the vicinity, or perhaps upon, Coal Rock, Ethel Rock, the Skerries, Platters, or other dangers hereabout. By night a *red* light from the Skerries will point out the position of Coal and Ethel Rocks; and the main light is obscured over the East Platters.

Beaumaris is a good harbour for ordinary merchant vessels, into which a Liverpool pilot will conduct them, provided no licensed pilot for the port may be found; but the Beaumaris pilot-boat is generally cruising off the chops of the bay, between the Ormes Heads and Lynas, or lying at anchor within it.

Holyhead is also an excellent harbour, fit for the largest vessels, well sheltered by the immense pier or breakwater.

(*b*) ON TAKING THE NORTH CHANNEL, AND PROCEEDING THENCE TO TORY ISLAND.

If, after weathering the Hoyle Sands, the wind should be so far to the Southward of West as to enable a vessel to weather the Isle of Man, it may be a matter of consideration whether it be most advisable to go through the North Channel or the South Channel, and this should not be hastily decided on. In the summer months the winds are more variable than in winter, and then it is certainly advisable to choose that passage which is nearest to the destined port, giving the preference to the North Channel if bound to British America, Newfoundland, or the Northern ports of the United States. In winter, the prevalent winds are from S.W. and W.S.W., and these winds often blow steady for several days.

Should the North Channel be preferred, with Southerly and S.S.W. to W.S.W. winds (and it should not be attempted with any others that have Westing in them, especially by a stranger), it is advisable to take a departure from the Calf of Man, and steer a direct and mid-channel course, with a careful look-out, as the passage is narrow and the tides very rapid, but running directly through the channel, the flood setting from the Northward toward the Mull of Galloway. With a W.S.W. wind it will be necessary to keep the Irish shore aboard, after passing the two lights on the Maiden Rocks; or it is possible, in a strong gale from this quarter, that there may be some difficulty in weathering the Isle of Islay.

The North Channel is well lighted, and has many excellent harbours fit for the largest ships, as Lough Foyle, Belfast Lough, Loch Ryan, Campbelton, Lamlash, &c., but it is advisable for vessels, if possible, to take those upon the Irish coast, as they can get to sea with Southerly and S.W. winds, when it may be difficult to get away from either Lamlash or Campbelton.

After passing Tory Island, on which there is now a Signal Station, do not be too anxious to make Southing, but steer well to the Westward, if possible; for there is always a very heavy sea and a strong indraught upon the West coast of Ireland, and strong Westerly and W.N.W. gales are very prevalent in the winter. Although there are some excellent harbours in the N.W. of Ireland, they may be considered as inaccessible to a stranger, owing to the great difficulty of procuring a pilot in the winter season; every exertion should, therefore, be made to keep off this dangerous and too often fatal coast.

The depth of water, or quality of soundings in the North Channel, will give little or no indication of the progress of the vessel, so that a good look-out is here the mariner's best safeguard; the coasts on both sides being bold, excepting about South Rock and Maiden Rock, both of which dangers are well lighted, but require a good berth in passing, particularly the latter.

In running through the North Channel with S.W. winds, every stitch of canvas should be carried that the vessel will possibly bear, as these winds often fly suddenly round to the N.W. quarter, *see* (122) and (128); and in that case blow so hard, for twenty-four or thirty-six hours, as to compel a vessel either to bear up for the South Channel, take a harbour, or lie-to in a narrow and dangerous channel for a more favourable wind.

(c) ON PROCEEDING BY THE SOUTH CHANNEL, AND THENCE WESTWARD TO THE OCEAN.

If it be intended to persevere in working down the South Channel, it will be the best way to keep the Irish shore aboard by short tacks, should the weather be squally with heavy rain, as the vessel will then have the benefit of the N.W. wind and smoother water, should it fly round to that quarter, as is often the case. In dry or moderate weather there is little fear of a sudden shift of wind; and a vessel, in such case, may make a long board toward the coast of Wales. Should it come on to blow from the S.W., with much rain, get the Irish coast on board as soon as possible, especially in the winter.

Vessels passing up or down the South Channel with Westerly winds will find a strong indraught setting into Carnarvon and Cardigan Bays, as well as into the Bristol Channel; and this may be probably, in some degree, accounted for by the following, and, perhaps, other causes:—Southerly, S.W., and Westerly winds prevail over the Atlantic, between the Azores and Great Britain, during eight or nine months of the year, causing the surface-current in this vast space to flow to the Eastward; the tides in the neighbourhood of, and to some distance Westward of Scilly, run nine hours out of the twelve to the Northward, or into St. George's Channel, which, like the Strait of Gibraltar, has some resemblance in form to the pipe of a funnel; and it is probable that, in gales of wind from the S.W. quarter, there is very little, if any, ebb from the Western edge of Channel Soundings to a position 45 miles West from Scilly, and thence to the Northward, on the same meridian, until within 45 miles of the South coast of Ireland; neither do I think it at all unlikely that a portion of the stream of "Rennell's Current," which frequently, as I shall hereafter show, runs with velocity to the N.W., may be diverted by Westerly gales into a more Northerly direction, and being opposed in its course by the South coast of Ireland, finds its way to the Eastward, and thus contributes to raise the level of the water, and make a strong tide or indraught into St. George's Channel.

This stream of tide sets E.N.E. toward the Tuskar, and nearly in the same direction, or a little more Northerly, toward the Smalls, and rushes with great velocity, past Skokham and Skomer, through the sound, towards St. David's Head, and along the South and East coasts of Cardigan Bay, from whence it diverges toward Bardsey Island; in the sound between which island and the main it runs with great strength.

It is generally advisable to keep the Irish shore aboard in turning down the St. George's Channel, with S.W. winds and heavy rain. In the South Channel the lead will impart some idea of the position of the vessel, or at any rate will indicate, by the depth of water, the probable distance of the vessel from the land. The banks on the Irish coast, between Howth Head and Arklow Bank, may be safely approached to 20 fathoms of water, and nearer should it be clear weather, which, by-the-bye, is not often the case in this neighbourhood. When near the N.E. end of Arklow Bank, and from thence to the Westward, no vessel should shoalen her water under 28 fathoms, without daylight and constant caution. The lights on these banks require close attention, as they have at times been mistaken. The tides of both flood and ebb run directly over these banks, in a N.N.E. and S.S.W. direction, and in light winds must be carefully attended to.

In beating to the Westward, should a vessel shoalen her water on the coast of Wales to 30 fathoms, she will be quite far enough inshore, and should tack immediately, for it should be recollected that there is 36 to 40 fathoms water very close to Bardsey.

Should a vessel be caught with hard N.W. gales upon this dangerous coast, every exertion must be used, by carrying taut well-set sail, to get the ship round Bardsey, on which is a lighthouse, when she will have St. Tudwall's Road (which is well sheltered with Westerly winds) under her lee. Should N.W. winds continue blowing hard, it will be better to run for St. Tudwall's Road, on the North, or to Fishguard Bay, on the South, than to persevere too long in attempting to work out of Cardigan Bay.

Any moderate-sized vessel may find good and safe anchorage in Fishguard Bay, by running in to 2 or 3 cables from *Cow Rock*, on the West side of the entrance, and anchor when the land to the Westward of it is shut in, and the rock bears North, distant 3 to 4 cables, in 4 to 5 fathoms at low water, over a bottom of stiff clay and mud, which holds remarkably well; and the ship will lie well sheltered with all winds, except those from North, around by the Eastward, to S.E. by E. or S.S.E.; N.E. winds throw in a heavy sea.

The coast in the vicinity of Fishguard Bay is clean and bold, and the bay may be readily distinguished from the offing by Cow Rock, which is always above water, off the Western point of the entrance, and by the remarkable appearance of Dinas Head (the Eastern point), which, upon an Easterly or S.E. bearing, exactly resembles the head of a large gurnet.

Were the advantages of Fishguard Bay more fully known, they would be duly appreciated. When the writer commanded the brig *Freeland*, of Liverpool, that vessel was disabled, by the loss of her sails, in the heavy N.W. gales which prevailed in December, 1833, and was obliged to run into this bay in order to save the vessel from a lee shore; and in this place she lay in safety, at single anchor, with 70 fathoms of chain, during the tremendous gales which caused the Liverpool lightship to part her moorings, and compelled her to run into the Mersey for shelter.

From what has been stated above, it will be seen that this bay is of easy access and egress, but it should never be used unless in a case of necessity, and then with a good and careful look-out at all times, and everything should be in readiness to trip the anchor at the moment the wind veers to the Eastward of North, if the weather be not very moderate and settled.

On weathering the Smalls, when outward bound, it is advisable to keep well to the Westward if the wind will permit, so as, on advancing Southward, to give Scilly a wide berth—say of 55 or 60 miles.

(*d*) ON PROCEEDING BY THE SOUTH OF IRELAND FROM THE OCEAN TO LIVERPOOL, ETC.

In coming from the Westward, many navigators endeavour to make the Fastnet Rock and Cape Clear, as it is high land, and there is an excellent revolving light on the former. The coast in the neighbourhood is also generally bold. But I do not think this is an advisable plan for a stranger, unless he has obtained good observations a very short time previously; for I have known sailing vessels to be detained several days in endeavouring to work round the cape against strong Southerly gales and a N.W. current —unquestionably Rennell's.

In two of these cases, one in 1836, and the other in 1839, two different shipmasters ran with confidence for Cape Clear, upon the faith of good observations for latitude, taken forty-eight hours previously, and both made the *Skelligs* on the starboard bow, when steering E. by S., with the wind from the Southward and S.S.W., thick weather and rain. When the Skelligs were near, one of these gentlemen considered his vessel to be on the parallel of the cape, and the other (in 1839) thought that he was at least 10 to 15 miles to the Southward of it. It may be proper, however, to add that the latter denied the existence of Rennell's Current, until he thus found the effect of it.

In thick, hazy weather, it may be well to run upon the parallel of 51° N. until the vessel gets into 65 fathoms or less water; then steer about E. by N., keeping the lead occasionally going and be careful not to advance into less than 40 fathoms, when a channel course of about East may be shaped, having constant recourse to the deep-sea lead. By proceeding in this manner, it is probable that the land will be made in the vicinity of Waterford, or about the Saltee Islands. Waterford may be known by the lighthouse on Hook Point, on the East side of the entrance of the harbour.

A little to the Westward of Waterford are the THREE towers on Great Newton Head, and TWO towers upon Brownston Head, as described in the Sailing Directory. The latter are about 6 miles to the Westward of the Hook Point of Waterford, and are too remarkable to be mistaken. The Saltee Islets are 11¼ miles to the Eastward of Hook Point, known by its tower and light. The *Great Saltee* is high, and may be readily known by the Coningbeg lightship, moored to the S.W. of it. No vessel should attempt to pass between the lightvessel and the land, if it can possibly be avoided, the passage between being rocky and dangerous.

The weather is often very thick on Nymph Bank, with the wind from the Southward and N.W. quarter, and the Tuskar is, consequently, very difficult to make. The Smalls and Tuskar, on the opposite sides of the channel, when seen in this thick weather, have often been mistaken for a large sloop with a peaked gaff-topsail set. No vessel should run with confidence up St. George's Channel without previously seeing one or other of the lighthouses on these rocks, or the land in the vicinity, as the tides are hereabout very strong, and hidden dangers abound near both, as shown by the charts. To the Eastward of Nymph Bank the weather generally becomes a little clearer than upon it.

The course may be safely altered when the Tuskar bears North, and an allowance of one point or more must be made for the direction of the wind, particularly if blowing from the N.W. quarter, as this wind not only increases the indraught into Cardigan and Carnarvon Bays, but it throws a heavy sea upon the whole line of the coast of Wales Northward of St. David's Head.

In running from the *Smalls* toward Holyhead, it is, at all times, advisable to steer a point or more to the *Northward* of the direct course, unless there is Easting in the wind; and should Holyhead or the South Stack Lighthouse be made upon a bearing to the *Northward* of N.E. by E. ¾ E., the course should be altered a little, to bring it upon this bearing, otherwise the vessel may find some difficulty in weathering it upon an ebb-tide, if the wind should come out from the N.W. quarter, as there is a strong set (along the land) to the Southward into Carnarvon Bay.

The island or rock called the *South Stack*, distinguished by its lighthouse, is very bold, but, with light wind and a flood tide, strangers should give it a berth of 3 or 4 miles, as there is much danger of being set inside tht Skerries, if this is not attended to. In light winds and a flood tide, steer well to the Northward, until the Skerries bear about E. by N., then gradually edge away to the Eastward, until the lighthouse bears about E. by S., distant 2 miles, when the flood tide, with a very little assistance from the wind, will carry a vessel safely to the Northward of it.

The Skerries may be approached by a stranger, on the North side, within a mile; and when the lighthouse bears S. by W., steer E. by N. 2 miles, and East 1 mile, or until the upper beacon on Carmel Point comes open to the Eastward of the lower one, when the vessel will be clear to the Eastward of Ethel and Coal Rocks. On proceeding thence, with a Southerly wind, give a small berth to the Middle Mouse, a large rock always above water, and very bold. On steering thence toward Point Lynas, take particular care not to shut up the light if it be in the night. Should the light happen to be shut up, instantly run to the Northward or N.N.E. until it opens, and heave-to or stand off and on for a pilot, about 4 or 5 miles to the Eastward of the light, or between it and Great Ormes Head.

In thick weather, after passing the Skerries, and at night if the light cannot be seen, great caution is requisite, in order to avoid Coal Rock, and keep clear of the ebb tide running through the sound; for, upon an ebb tide, the land between Point Lynas and the Skerries must not be approached within 3 or 4 miles without a commanding and favourable breeze.

Vessels bound to Liverpool should make signal for a pilot immediately after passing the Skerries, as the pilots are very often well to the Westward, and keep a diligent look-out; but should no boat be seen, cruize about for one between Lynas and the Ormes Heads, as the tides here do not run strong; but do not, on any account, run a single mile to the Eastward of the Great Ormes Head; for, should thick weather come on, the vessel will be in danger of being upon the West Hoyle or Burbo Banks, and lost. It sometimes, but rarely, happens, when an unusual number of vessels come up on one tide, that there is no pilot-boat on the Lynas station, but it will only be left for a few hours, and vessels should wait with patience, for *here* a pilot is *sure* to be obtained.

The Liverpool pilots are under very excellent regulations, are exceedingly skilful in their profession, and in point of character and conduct are not surpassed by any similar body of men on the coast of Great Britain.

Although I have before noticed the necessity of an unremitting attention to the lead in thick weather, perhaps I may be excused for adding here, that such attention is of the *greatest importance*; as, owing to the velocity of the tides, it affords the mariner the only certain indication of his safety or danger, and contributes to relieve his mind, in some degree, from the anxiety he must feel whilst his vessel continues within the limits of this dangerous navigation.

4.—PASSAGES BETWEEN ENGLAND AND GIBRALTAR.

By giving due attention to what has been stated previously, regarding the winds and currents prevailing on the West coast of Europe, steamers will find little to contend with in making this passage in ordinary weather, whether outward or homeward bound. Every precaution must, however, be taken when in the vicinity of Ushant, the N.W. coast of Spain, Capes St. Vincent and Trafalgar, and other projections of the coast, especially in thick weather.

Sailing vessels outward bound, with a favourable wind, may steer a direct course as far as possible, making full allowance for passing well to the Westward of Ushant and Cape Finisterre. If bad weather comes on, it is advisable to make to the Westward as far as 10° or 12° W., rather than risk being set into the Bay of Biscay. From off Cape Finisterre, it is advisable to give the coast to the Southward a good berth, sighting Cape St. Vincent, and then proceeding according to wind, weather, &c.

Sailing vessels homeward bound, after passing Cape St. Vincent, endeavour to get an offing of 100 or 150 miles, to avoid the current running near the coast, proceeding to the Northward as the winds will allow.

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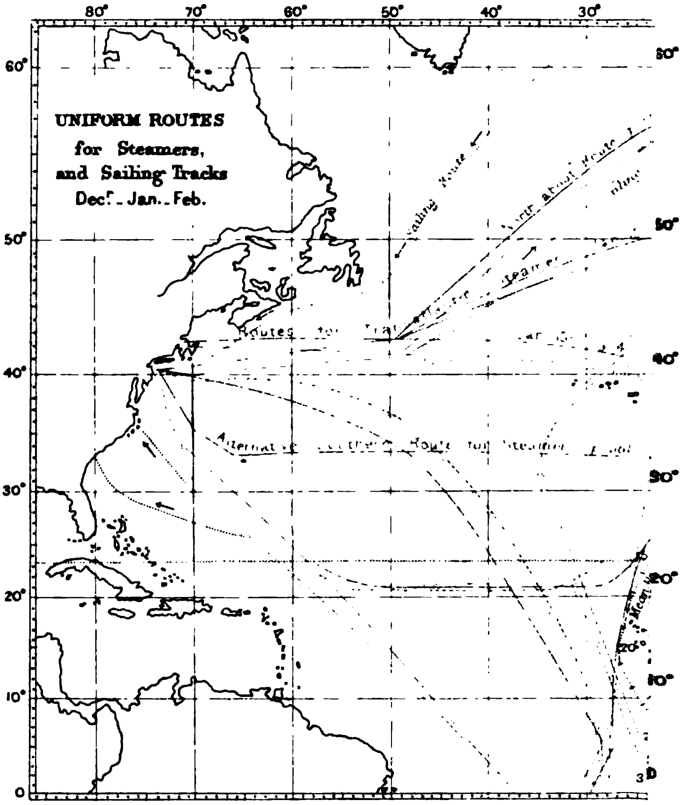
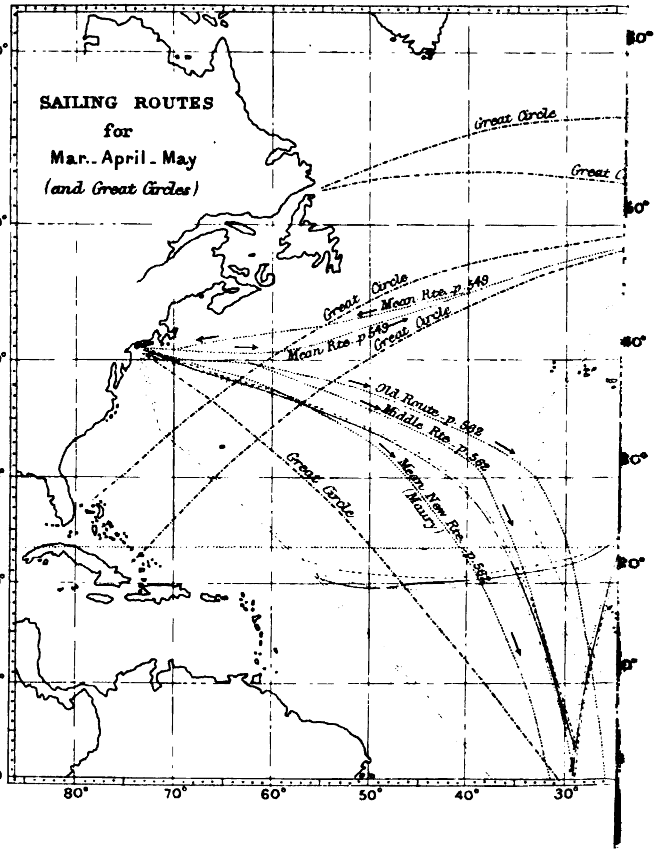


SPRING ROUTES



5.—ACROSS THE EQUATOR.

It is probable that there has been more discussion upon the route from the British Isles to the Equator, and on the best meridian for crossing the Line, than upon any other passage. And yet the results of these inquiries as to this, the great highway of the ocean, have served to confirm in a great degree the opinions published in the early days of navigation, before any of the modern improvements and appliances had been brought to bear upon it.

The directions given by M. D'Aprés de Mannevillette, in his great "Neptune Orientale," published nearly a century and a half since, might be followed now without losing much of the advantages which deep study, and extensive inquiry into data lately acquired, would give to the shipmaster.

Captain Maury, at the time of the publication of his "Wind and Current Chart," in 1849, first advocated a more Westerly crossing of the Equator than had been before pursued. This arose from looking at the voyage from the opposite side of the Atlantic to that on which all previous sailing directions had been composed. The configuration of the land about the Equatorial portion of the Atlantic is peculiar, and causes the difficulties of a trans-equatorial voyage. The Eastern point of the continent of South America, Cape San Roque, the "great bugbear," as Maury calls it, and the land about Pernambuco, lying in the strength of the S.E. Trade, and the consequent strong current to leeward which runs past it, were constantly the dread of the older mariners, whose ships made so much leeway, and were incapable of sailing on a wind as our modern clippers do. But from the improvements in ships and their rig and management, much that was formerly insuperable is now quite practicable, and many of the difficulties of clearing Cape San Roque have vanished upon later inquiry.

The other difficulty which also combines with Captain Maury's argument, is the intervening belt of Calms and Monsoons (extending nearly across the ocean between the Trade Winds), which has a triangular form, the base lying upon the African coast, between Cape Verde and the Equator, and gradually getting narrower to the Westward, and therefore by crossing it well to the Westward it is traversed in a shorter distance, and the detaining effects are much less experienced.

The work of Captain Maury, although it has done good service, must now to a great extent give place to the more recent works of Captain Toynbee, published by our own Meteorological Office.* In these the

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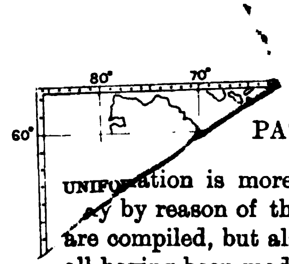
* (1). Charts of Meteorological Data for Square 3, Lat. 0°—10° N., Long. 20°—30° W.; and Remarks to accompany the Monthly Charts, which show the Best Routes Across the Equator for each month, &c. 1874.

(2). Charts of Meteorological Data for the Nine 10° Squares of the Atlantic, which lie between Lat. 20° N. and 10° S., and extend from Long. 10° to 40° W., with accompanying Remarks, ending with the Best Routes Across the Equator. 1876.



UNIFO[illegible]ation is more reliable than that afforded by Captain Maury, not [illegible]y by reason of the larger number of the observations from which they are compiled, but also because of the greater accuracy of the observations, all having been made with instruments tested and owned by the Meteorological Office. The period over which the observations extend is mainly between the years 1855 and 1870. They were nearly all collected and arranged by the late Admiral FitzRoy from British ships of the Mercantile Marine.

Captain Toynbee (in the introductory remarks to the latter of the two works mentioned in the note on the preceding page) says :—"The part of the sea with which we are about to deal is of the greatest importance to the navigator, as it contains the much dreaded Doldrums, through which every ship bound to the Southward of the Equator must pass; and it is no uncommon thing for sailing ships to lose a fortnight, or even three weeks, through taking a wrong route for the month."

In treating, therefore, of the third portion of this subject, or that which relates to the passage from Madeira to and across the Equator, we shall in the first place give Captain Toynbee's remarks, and afterwards such information from former editions of this work as may be thought worthy of the sailor's perusal.

Reference should be made to the Diagrams accompanying this Section, page 459; these are chiefly drawn up from those issued by the United States Hydrographic Office, which are founded on averages of a great number of observations. The routes recommended by Maury and the earlier hydrographers are also marked on them, for easy reference and comparison.

For *Steam-ships*, the Great Circle route from the Lizard to Cape Horn is probably nearly the best that could be followed, even if it were not the mathematical course. It passes near to the West end of Madeira and the Cape Verde Islands, as directed for sailing ships, and then crosses the Equator in longitude 31¾° W. It almost touches Pernambuco, and passes close to Rio de Janeiro towards the Strait of Le Maire, the total distance being 6,988½ miles.

Again, the Great Circle route from New York to the Cape of Good Hope is a good route for steam-ships out or home. It cuts the Equator in 22° W., passing through Ascension and just Westward of St. Helena, the distance being 6,877 miles.

To steam-vessels there will be no difficulty in following either of these nearest routes, and they will only be modified in sailing vessels by the force of the Trade Winds, which will make the course through the Trades more Southerly than the Great Circle, in going Southward.

Although a voyage round either of the great Capes—the Cape of Good Hope or Cape Horn—involves a more extended problem than that of the passage over the North Atlantic Ocean, with which this book especially deals, yet the difficulties and all phenomena which regulate the whole voyage are encountered North of the Equator, and therefore the discussion of the voyage to the Equator includes the whole problem, and what would follow for the South Atlantic is simply and easily carried out.

The GENERAL INSTRUCTIONS for making the passage from the English or St. George's Channels to the Equator may be briefly summed up thus:—

1. From the Lizard or the Tuskar, steer about W.S.W. (*true*) to gain an offing, to longitude 10° or 12° W.
2. From thence steer so as to pass to the Westward of Madeira.
3. Thence to the West of the Cape Verdes, and across the Equator.

Each of these portions of the voyage will be discussed separately.

1. LEAVING THE CHANNEL.

The Great Circle course from the Start to Pernambuco, commencing *S.* 37¾° *W.*, *true*, carried on for 1,220 miles, passes 15 miles outside Ushant, 45 miles off Cape Toriñana or Cape Finisterre, and 30 miles West of Madeira. With every circumstance in a sailing vessel's favour, this course made good may be followed; but, as will be seen by former discussions, she will be affected by numerous causes, which generally have a tendency to place her to the Eastward of her course, and thus involve her among the dangers of the French and Spanish coasts.

A much more prudent course is at once to make your Westing after leaving the entrance of the Channel, as time will generally be saved by so doing, and all uncertainty avoided.

Therefore steer to the W.S.W. or S.W. by W. (*true*) in *fine weather* after passing Bishop Rock or the Lizard, until the longitude of 10° or 12° be attained. By doing this, the perplexing influence of the revolving tides which occur between the Start and the French coast (page 285), will be in some degree avoided. Again, the occasional Rennell's Current (pages 301—312), will less affect a vessel, or if strong, will assist her in making the necessary offing.

But the most important object, in thus early in the passage getting to Westward, is to avoid the well known indraught into the English and St. George's Channels and the Bay of Biscay (see pages 301—311). This Eastward tendency of the wind and current would, if not properly estimated, cause some difficulty in weathering Ushant, should the wind become at all adverse, and the strong tides and dangerous navigation, around these projecting, headlands, render them very unpleasant neighbours.

It is probable, too, that the wind may veer more to the Westward, as you get beyond the influence of the St. George's Channel, which draws it towards a more Northern direction; and again, as Westerly winds have a tendency to veer to the N.W., if you have plenty of sea-room, you can pursue your course a point or two free. With the wind decidedly contrary to making a course to the South of West on reaching the chops of the Channel, it may become a question as to how far a more Northerly route is advisable.

In a discussion on the Packet Service about 1834, when a Western port of Ireland was advocated as a better starting place than Falmouth, Sir Francis Beaufort drew up a comparison of 60 passages made by the Falmouth Packet, in contrary winds (30 outwards, 30 homewards), and what would have been the advantage had Cape Clear been the starting place instead of Falmouth, the desideratum being of course the safe weathering of Ushant and Cape Finisterre. Of course this was previous to the Steam Mail Service, and when the Falmouth Packets were in a high state of efficiency, that is, from 1826 to 1830. Sir Francis Beaufort constructed the diagrams by laying off the tracks of the vessels from Cape Clear as if sailing with the same wind as that experienced by them in sailing from Falmouth. The average time occupied by the 30 outward packets from Falmouth to lat. 42° 40′, off Cape Finisterre, was 9 days 12 hours, varying from 12 days to 6 days. Had the packets started from Cape Clear, they could have arrived at the same parallel in a mean time of 4 days and 21 hours, thus showing a saving of 4 days 11 hours, or nearly one-half. In the homeward route, the same mode of calculation showed that 4 days 9 hours may be saved in the same manner. Now, as Cape Clear is about the same distance from Madeira as the Land's End, it is evident that a vessel is in no worse a position by approaching it. Crookhaven, or some of the harbours on the S.W. coast of Ireland, will afford her shelter as well as those on the S.W. coast of England.

This is said in case the vessel encounters strong head winds which will not allow her to make Southing, which, after all, is the grand object, in order to quickly gain the N.E. Trades. If the ship will not lay better than N.W. on the port tack, perhaps it is better to make a short board until the wind veers a little either way. If you are well to the Westward of Ushant, and the weather moderate, supposing the ship will lay South or S. by W., you may safely stand on to the Southward; but should the weather be threatening, and a Westerly gale apprehended, it will be prudent to keep the Channel open, rather than by beating to windward, you get past Ushant, and may thus get embayed on the dangerous French coast, where also the wind is liable to shift close inshore. By keeping the English Channel under your lee, should you not be able to maintain your course, you may then run for some shelter.

From recent French Government researches Westward of Ushant, it is found that for many miles Westward of the meridian of the outer dangers off that island, the bottom is so generally level, with numberless local irregularities, that no attempt can be made to judge the distance from shore by the lead alone. A vessel bound North will, however, pass well clear of Ushant by keeping in a depth exceeding 60 fathoms, making due allowing for the range of tide, which near Ushant exceeds 3 fathoms at springs. A little over 4 miles N.W. of Ushant is a remarkable depression, 7 miles long N.E. by E. and S.W. by W., by 1½ mile across, with depths of 70 to 105 fathoms.

2. Passage to Madeira.

When the ship is sufficiently to windward of Ushant or Cape Finisterre, there can be no difficulty in making for Madeira, so as to pass to the Westward and within sight of it.

Cape Finisterre should be passed at a considerable distance, or, at least, the course should be so shaped to do so, for fear of the prevalent drift which is frequently powerful along the North coast of Spain, and the effect of the prevalent Westerly winds to horse the vessel to leeward and into the Bay of Biscay, which is especially to be avoided. The prominent headlands of the coast of Spain being now marked by lighthouses,* there is less danger of mistaking the country than there was formerly, as in many parts it is difficult to make out the bays and the inlets, and of course it is a most dangerous iron-bound and lee-shore.

We have previously, on pages 308—309, drawn attention to the necessity of guarding against the insidious Easterly drift into the Bay of Biscay, with some account of recent disasters arising apparently from neglect of due precaution. When bound to the Southward, in overcast weather, and the dead reckoning shows that the vessel must be approaching the parallel of Cape Finisterre, at night especially, care must be taken by the use of the deep-sea lead, and other precautions, to ascertain the true position, as the lights cannot always be depended on.

By sighting Madeira an opportunity is afforded of testing the rate of the chronometers, as a sufficient interval will have elapsed to gain a sea-rate, and having it thus early in the voyage will avoid much uncertainty in the subsequent passage. It may be stated that any point of the island will answer equally for giving a longitude. The tables on page 45 will give the positions of the most prominent points, or the description and chart hereafter will give further information.

It is better to pass 20 or 25 miles off Madeira, as the winds are generally steadier in the offing, particularly in winter. In November, December, and January, Westerly gales prevail, which produce eddy winds and severe squalls near the land, occasioned by the mountains obstructing the regular course of the gales, and beside the weather here is then very precarious.

However, notwithstanding all that has been said in former directions as to passing within sight of Madeira and the Cape Verdes, it is a question whether a more Westerly course to the Equator may not be attended with some advantages. There is some reason to think that the nearer the land the more baffling and uncertain the wind is, and as its tendency is to the Eastward, it is argued that some gain of time has been found to arise from crossing the parallel of 30° (as well as the Equator) on a more Westerly meridian than that of Madeira.

Captain Maury says:—The winds along this route are an exact counterpart of those found in the Pacific, on the route from California to Peru, Chile, or Cape Horn; for the deserts of Mexico and the United States hold very nearly the same relation to the N.E. Trade Winds of the Pacific that the deserts of Africa do to those of the Atlantic; and though quick runs may be made now and then, both along the West American and West African coasts, yet, in the long run, experience in the Pacific has amply proved that the navigator saves time by keeping off from the coast, and so I apprehend it will be here. Indeed, experience in the Atlantic goes directly to show the same thing, and to place the opinion almost out of the category of conjecture, for this is the very point upon which the advantages of the new route from the United States to the Line are based.

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* As will be seen by a reference to "Lighthouses of the World," there are frequent reports of many of the Spanish lights being at times unreliable, so due caution must accordingly be exercised.

The following abstract was made by Lieutenant Maury in the earlier editions of his "Sailing Directory" (in 1855), and showed the average number of days that it took from lat. 30° N. to the Equator, in the several crossings, by 86 vessels :—

East of 16°	24	days from the mean of	6	vessels.
Between 16° and 17°	23	„	6	„
„ 17° „ 18°	24	„	14	„
„ 18° „ 19°	24	„	22	„
„ 19° „ 20°	23	„	19	„
„ 20° „ 21°	22	„	6	„
„ 21° „ 22°	21	„	7	„
„ 22° „ 23°	18	„	6	„

Thus, the farther the place of crossing the parallel of 30° is to the West, so is the average passage thence to the Equator diminished. East of the meridian of 19°, the average passage, as far as the data of these tables may be relied on, is about 24 days. To the West of 19° the ratio of decrease as to length of passage, according to this showing, is most rapid.

The passage to the Line from England and the English Channel ought not, on the average, to be as long by several days as it is from the United States. In the first place, the distance from the Land's End is not so great by two or three days' sail; and, in the next place, the winds are fairer. Vessels bound to the Line from any of the Atlantic ports of the United States have to sail close-hauled most of the way, but from Europe they go free.

If the performance of the ships whose abstract logs I have, which furnish the data for these tables, be a fair specimen of what ships generally do on this route, and I suppose it is rather above than below, it would appear that the average passage the year round to the Line from England and the English Channel is 36 days; the months giving the longest averages, such as they are, being January and March 47 days, August 46, and June 39. The first two are evidently too long, their averages being determined from only two or three passages each. The average to the Line from the United States has been brought down from 41 to 31 days; and the average from the British Isles and English Channel can be, I am encouraged to believe, reduced to less than the American average.

In the meantime, the route which I venture to recommend—not, however, without some misgivings, arising from the want of more ample data—is the same, very nearly, for all vessels from whatever part of Europe.

They should aim, whenever the wind will allow the option, to cross the parallel of 30° N., between the meridians of 25° and 30° W., but should not contend with adverse winds for it; having reached this crossing, their course thence is due South for the Line, between the same meridians. In summer and fall they should enter the Southern hemisphere about the meridian of 30°, but during the rest of the year they will generally not be

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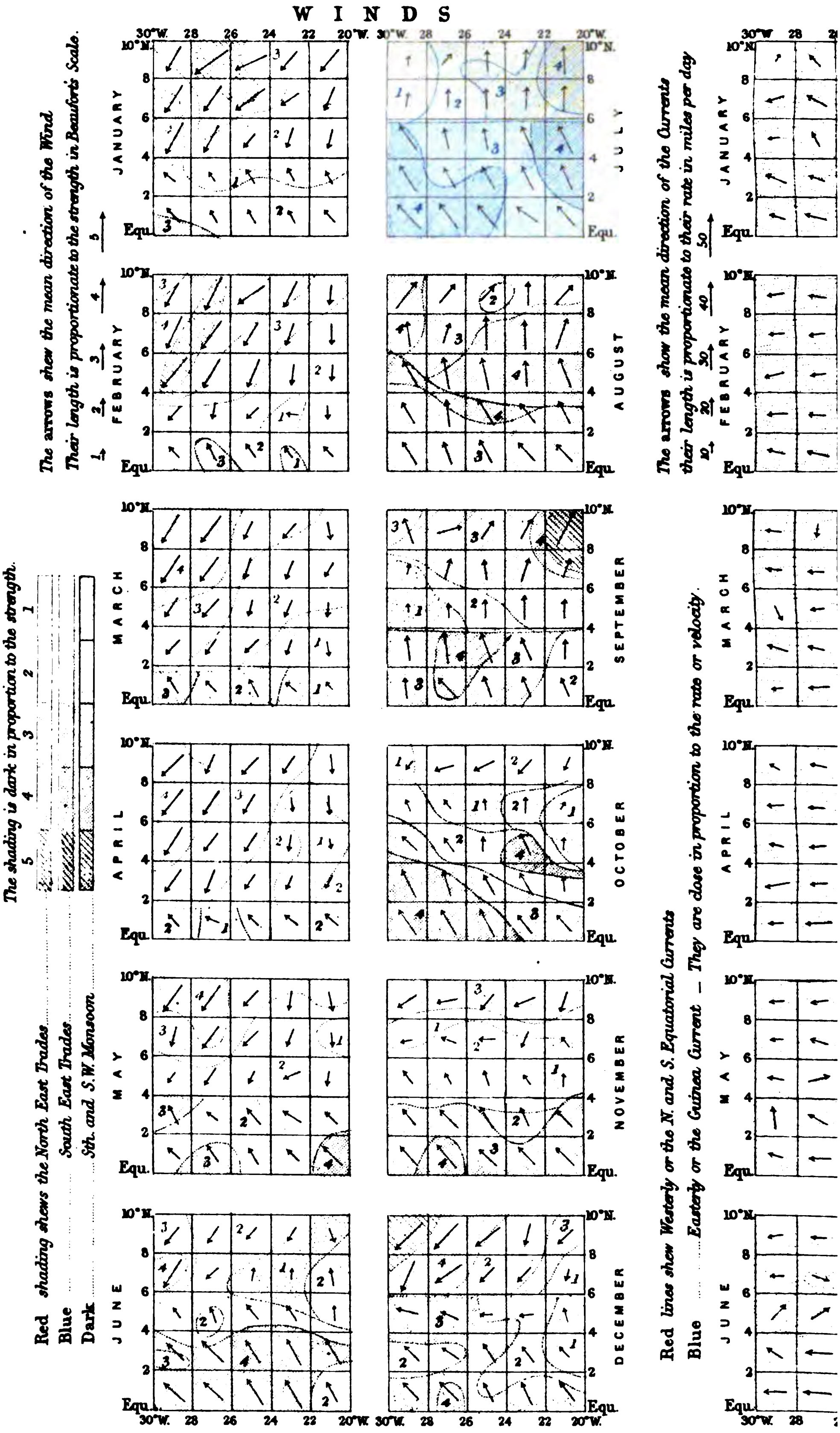


The arrows shew the mean direction of the Wind
Their length is proportionate to the strength in Beaufort's Scale.
1 2 3 4 5

The shading is dark in proportion to the strength.
5 4 3 2 1

Red shading shews the North East Trades
Blue ...... South East Trades
Dark ...... Sth. and S.W. Monsoon

The arrows show the mean direction of the Currents
their length is proportionate to their rate in miles per day
10 20 30 40 50

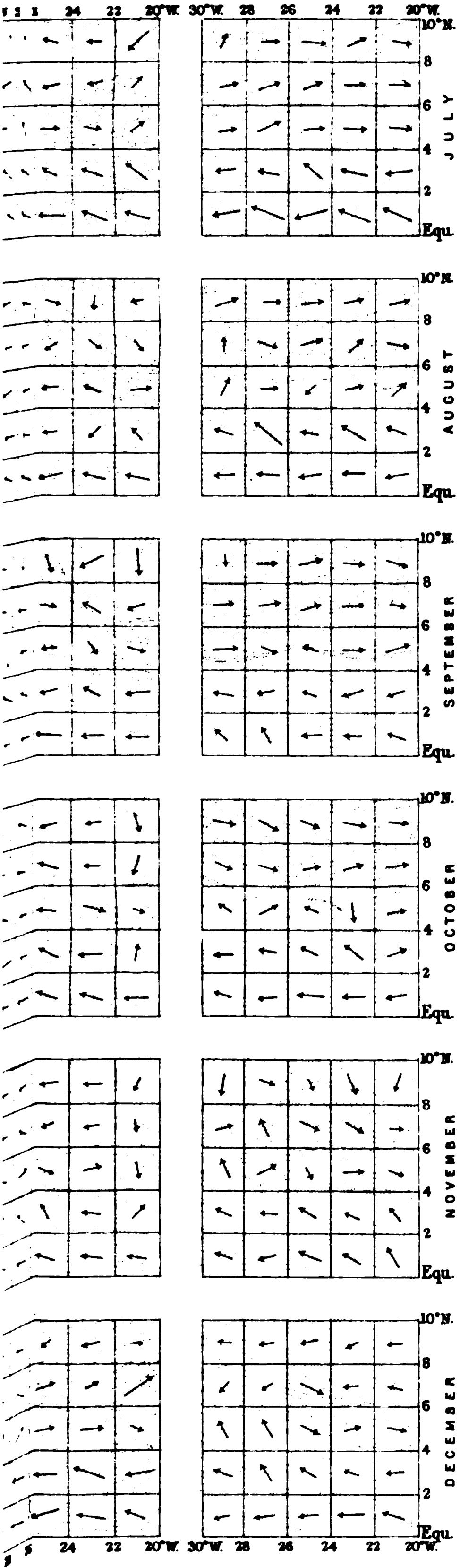
Red lines show Westerly or the N. and S. Equatorial Currents
Blue ...... Easterly or the Guinea Current — They are close in proportion to the rate or velocity.

A.G.F. del.t

The Meteorology &c. of Square N.o 3, from 0° to 10° N.

S.A. p 174
N.A. p ~~466~~

CURRENTS



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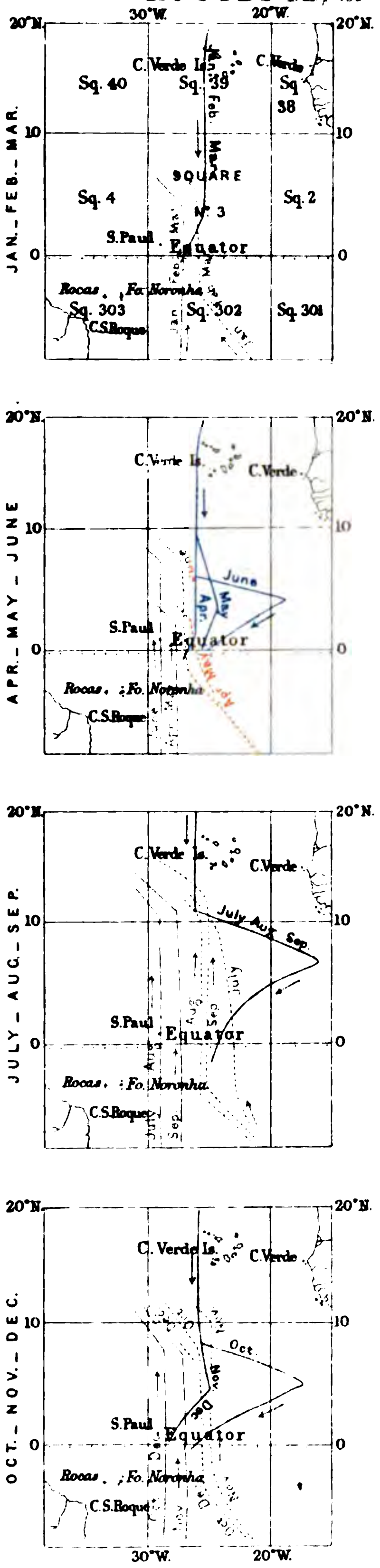

Outward Tracks *are coloured* blue _ Homeward Tracks *coloured* red { *from the Westward thus* ——— *Eastward* ....

and from 20° to 30° W. *By Captain Henry Toynbee F. R. G. S.*

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forced so far over to the West, though they should not care to go East of longitude 25°.

Vessels from as far North as the English Channel, should aim to cross the parallel of 40° between the meridians of 20° and 25°; and for this reason—besides that of winds a little more propitious—viz.: In crossing the Calms of Cancer the navigator wants to be in such a position that he may always be able to go on that tack which will carry him most rapidly across this belt of calms. In other words, he wants to be in that position where it is immaterial to him whether he be making Easting or Westing, provided he be on the tack which will give him the most Southing. For this reason he should aim to enter the Calm Belt between longitude 25° and 30° W.

The average crossing place of 30° is about the meridian of 19° W.

The above remarks of Captain Maury will be found useful as a guide in approaching the region discussed in the following section of our subject. Captain Toynbee's remarks will, of course, supersede those above given, relating to the Crossing of the Equator.

3. Approaching and Crossing the Equator.

In the earlier editions of this work, we had only the experience of American and Dutch shipmasters as a guide in forming an opinion as to the best routes East or West of the Cape Verdes, and across the Equator. However, since the publication of the valuable works of our own Meteorological Office, mentioned at the commencement of this section (page 475), what formerly was the only guide, must be treated as a minor consideration, and is therefore only briefly alluded to hereafter (page 493 *et seq.*).

The works of the Meteorological Office, to those with leisure to properly study them, will be found both interesting and valuable. In the adjoining diagrams, of course, but a very brief description is given, compared with that in the elaborate charts which accompany the original works. Reference should also be made to the diagram of the Passages accompanying this section, in which the routes over the Ocean are shown graphically, for each month of the year.

A warning is here given that the *Direction* of the Wind or Current is only shown from that point at which it was most frequently observed, and the *Force* of the Wind or Current from that direction alone indicated. Captain Toynbee's remarks supply further detail, and will, we believe, make what is here given from these valuable works quite sufficient for the sailor's requirement.

Square 3* lies so much in the highway of all ships passing to and fro, between the North and South Atlantic Oceans, that it contains nearly 60 per cent. of the 125,000 observations from which the charts are constructed.

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* The ocean was divided into 10° Squares, at the suggestion of Mr. Marsden, formerly Secretary to the Admiralty, and the numbers then given to the various squares have been adopted by the Meteorological Office in their marine work.

In several of the squares the number of observations is so small that it would be useless to give them on monthly charts for each 2° square, as was done for Square 3; they have therefore been sifted into spaces of 2° of latitude by 5° of longitude. This method has the advantage of enabling us to represent a larger space on the same chart; and in most instances the spaces seem to be small enough to point out any differences which actually exist.

Captain Toynbee remarks:—Having thus given a general view of the work we have in hand, I will now refer to the monthly diagrams, and also call attention to some interesting facts which have struck me in writing the remarks. Perhaps I ought first to say that in several instances the number of observations is so small that the Isobars, Isotherms, and Wind and Current arrows are not always so correct as a larger amount of data would make them; still in Square 3 (which is the centre of the district) and in Squares 39, 301, and 302, there is a large number of observations, so that the general result is satisfactory; for we find that the same month in different years has very much the same kind of Wind and Weather. I may add that though all data have been referred to the centre of the space to which they belong, it sometimes happens that nearly all the observations have been taken on one side of that space.

In the first place, then, it will be seen that we are dealing with a part of the sea where the two Trades are always meeting, though the latitude in which they meet varies with the season. This work therefore gives the meteorologist a constant opportunity for studying the motion of air where two air currents meet, and also the weather resulting therefrom.

Besides the meeting of two currents of air there are also two currents of water, which are mainly produced by the Trade Winds, and apparently increased in speed by the drift of water forced against Africa by the winter gales of each hemisphere. The direction of the Trades tends to draw water away from the coast of Africa, and as the land prevents an influx of water from the Eastward, there is a third current or back-drift to the Eastward into the Gulf of Guinea, to replace the water drawn away by the Trade Winds. This is the well known Guinea Current, which seems to be chiefly the result of gravity.

It must be remembered that Winds are named after the direction *from* which they come, whilst Currents are named after the direction *towards* which they go; for instance, an arrow pointing to the North-Westward represents a S.E. wind, but a N.W. current; therefore, in the diagrams the *tails* of the wind-arrrows and the *heads* of the current-arrows point towards the points of the compass after which they are named.

Remarks on *Winds*, of the regions under consideration, for each month, are given in pages 136—140. On the *Currents:* North African Current, 313—315, Guinea Current, 332—334, North Equatorial Current, 344—345, the South Equatorial Current is described in pages 347—353. Beaufort's Scale of Wind (Force) is described in pages 103—104.

BEST MONTHLY ROUTES ACROSS THE EQUATOR, BY CAPTAIN TOYNBEE, F.R.G.S., F.R.A.S., ETC.

Although the following suggestions are considered to be the *safest*, when giving advice for all classes of ships, they are not intended to over-ride a captain's own judgment, for he has the advantage of knowing the qualities of his own ship. The navigator should first consult the diagrams of the month in which he is about to pass through the district; they will show him the direction and strength of the *Prevailing* Winds and Currents he is likely to meet with.

Special attention is necessary in critical parts of the sea, such as that near Cape St. Roque, where at one season of the year outward-bound ships are liable to be caught by Southerly winds and leeward currents, and at another season of the year homeward-bounders by light North-Easterly and Northerly winds.

By Captain Toynbee's wish we add the following to his remarks :—

" The navigator must remember that it is impossible to lay down fixed tracks for him to follow, because the winds are not always the same at the same time of year. The tracks given on the accompanying diagrams are those which it is probable the wind will permit him to follow. Sometimes he will be able to do better than to strictly follow these tracks; at others he may be driven to do worse. He should not go out of his way to follow them, neither should he be guided by them alone, but, by reading the remarks on the following pages, form an independent opinion.

" To the Outward-bounder the tracks indicate the best routes for wind, and a safe longitude for crossing the Equator into the region of the S.E. Trades, keeping clear of the coast of South America. To the Homeward-bounder they indicate the best routes for wind across the Equator and up to the Southern limit of the N.E. Trades."

January.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, for although the wind is equally strong close to their Eastern side in January, it is decidedly stronger on the Western than on the Eastern side of Square 3.

Although the North-Easterly Wind prevails to the Equator West of the meridian of 30° W., and fast weatherly ships have done well after crossing the Equator to the Westward of that meridian, others have been hampered by the land, which is shown by the January Wind remarks. A dull sailing ship which crossed the Equator in 32° 45′ W., on December 13th, was 25 days before she cleared the land! The safest Westerly limit for such a dull sailer is 26° to 27° W.

Winds.—Referring to the Eastern half of the January Wind Chart for Square 303, and taking S.E. by E. as a central point, then when the Wind is not from that point:—

Between 0° & 2° S. the prob. is about equal that it will either be more Southerly or more Easterly or N.-Easterly.*
„ 2° & 4° S. „ „ 2 to 1 that it will be more Southerly.
„ 4° & 6° S. „ „ 4 to 8 „ „ „
„ 6° & 8° S. „ „ 4 to 8 „ „ E.-ly. or N.-Ely.
„ 8° & 10° S. „ „ 4 to 1 „ „ „

Current.—The January Chart for Square 303 shows a prevailing Westerly Current of from 20 to 30 miles in 24 hours, and that it is stronger in the Northern than in the Southern half of the square. Exceptional currents, considerably stronger than the means shown on the chart, are sometimes recorded. The chart shows a large per-centage of smooth sea in the month of January.

The above-named facts, taken together with the qualities of his ship, will enable the navigator to decide on his best route.

Ships bound to the Northward should cross the Equator between 25° and 30° W., so as to avoid the light North-Easterly Winds which sometimes blow near the South American coast in this month, and also to pick up the fresh N.E. Trade, which prevails in that longitude between 4° and 6° N., but not farther to the Eastward.

February.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, as the Western sides of Squares 39 and 3 have stronger winds than their Eastern sides. They should stand to the Southward in about 26° W., and when they meet the Southerly Wind, take the tack which gives the most Southing, endeavouring not to cross the Equator to the Westward of 28° W.

Winds.—Referring to the Eastern half of the February Wind Chart for Square 303, and taking S.E. by E. as a central point, then when the Wind is not from that point:—

Between 0° & 6° S. the probability is about equal that it will be more Southerly, Easterly, or North-Easterly.
„ 6° & 8° S. „ „ slightly in favour of its being more Easterly or North-Easterly.
„ 8° & 10° S. „ „ about 2 to 1 that it will be more Easterly or North-Easterly.

Current.—The prevailing Current is still Westerly, averaging from 20 to 30 miles a day, and generally stronger in the Northern than in the

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* In working out these probabilities all observations of wind from North have been considered as North-Easterly, and all from South have been considered as Southerly. The few observations from the Western half of the compass have not been included.

Southern half of the square. The chart shows that confused seas are not uncommon.

The Remarks on Wind, for Square 303, show that ships which crossed the Equator to the Westward of 30° W. were not much hampered, but there seems to be no inducement for vessels to cross to the Westward of longitude 28° W.

Ships bound to the Northward should carefully avoid the Eastern side of Square 3, where the North-Easterly Wind is light, and there is much light North-Westerly Wind; they should cross the Equator to the Westward of 25°, and to the Eastward of 30° W., by which means they will not get too near the coast of South America, where light North-Easterly Winds are not uncommon.

March.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, the N.E. Trade being stronger on the Western than on the Eastern sides of Squares 39 and 3. The March diagram shows that between 35° and 40° W., North-Easterly Winds prevail to the coast of South America, and to 2° S. between 30° and 35° W.

Winds.—Referring to the Eastern half of the March Wind Chart for Square 303, and taking S.E. by E. as a central point, then, when the Wind is not from that point:—

Between	0° & 2° S.	the prob. is	about	3 to 1	that it will be	more E.-ly. or N.E.-ly.
"	2° & 4° S.	"	"	3 to 2	"	" " "
"	4° & 6° S.	"	"	3 to 2	"	" Southerly.
"	6° & 8° S.	"	"	5 to 4	"	" "
"	8° & 10° S.	"	"	5 to 3	"	" E.-ly. or N.E.-ly.

Current,—The prevailing Current in this part is still Westerly, though now inclined more to the Southward, and its rate from 20 to 30 miles in 24 hours; it is strongest between 2° and 6° S., weakest between 8° and 10° S. There is a large per-centage of smooth sea in March.

The Remarks on Wind, for Square 303, show that ships which crossed the Equator between 29° and 30° W. were hampered by the land; so that it seems best to cross the Equator in 27° or 28° W.

Ships bound to the Northward should cross the Equator between 26° and 30° W., this will enable them to avoid the North-Easterly Winds which are common in Square 303, and, on the other hand, the light North-Westerly Winds and Calms which are common on the Eastern side of Square 3.

April.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, for although the N.E. Trade is as strong on the Eastern as on the Western side of Square 39, it is much stronger on the Western than on the Eastern side of Square 3; they should then stand to the Southward in about 26° W., taking the tack which gives the most Southing when the wind draws Southerly.

Winds.—Referring to the Eastern half of the April Wind Chart for Square 303, and taking S.E. by E. as a central point, then, when the Wind is not from that point:—

Between 0° & 4° S. the prob. is about 3 to 1 that it will be more E.-ly or N.E.-ly.
„ 4° & 6° S. „ „ 5 to 3 „ „ „
„ 6° & 8° S. „ „ 4 to 3 „ „ Southerly.
„ 8° & 10° S. „ „ 3 to 2 „ „ E.-ly. or N.E.-ly.

Current.—The prevailing Current is still Westerly, at a rate of from 20 to 30 miles in 24 hours, exceptional currents being stronger; it is strongest between 2° and 8° S. There is a good deal of North-Easterly swell in the N.E. part of Square 303, and of smooth sea in its S.E. part.

Near the South American coast there is much light North-Easterly Wind, and it does not seem likely that a ship would have great difficulty in getting to the Southward there; still the wind is lighter in Square 303 than in Square 302, and the Remarks on Square 303 show that ships which cross to the Westward of 30° W. are sometimes hampered; it would therefore be well not to cross the Equator to the Westward of 27° or 28° W.

Ships bound to the Northward should cross the Equator between 25° and 30° W., so as to avoid the large amount of light North-Easterly Wind which is recorded in Square 303, and the light North-Westerly Winds and Calms which are common on the Eastern side of Square 3.

May.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, where the May diagram and chart show the Wind to be stronger than to the Eastward. In Square 3 the North-Easterly Wind prevails to 4° N., and is stronger between 25° and 30° W. than between 20° and 25° W.

Winds.—Referring to the Eastern half of the May Wind Chart for Square 303, and taking S.E. by E. as a central point, then, when the Wind is not from that point:—

Between 0° & 2° S. the prob. is about 2 to 1 that it will be more E.-ly or N.E.-ly.
„ 2° & 4° S. „ „ 5 to 3 „ „ „
„ 4° & 6° S. „ „ 5 to 4 „ „ Southerly.
„ 6° & 8° S. „ „ 2 to 1 „ „ „
„ 8° & 40° S. „ „ 4 to 3 „ „ „

From October to April the wind draws more Easterly in the Southern part of the square, but from May to November it draws more Southerly.

Current.—The Westerly Current is stronger than in previous months, and frequently exceeds 30 miles in 24 hours; it is strongest between 2° and 6° S. The sea is also higher than in previous months.

It may therefore be well for a dull sailing ship to make a little Easting after passing the Cape Verd Islands, more especially as the Remarks on Wind, for Square 303, show that the Wind, Weather, and sea near the South American coast are very trying. In one case the ship crossed the Equator in 26° 18′ W., but still was much hampered. Hence it seems right that a dull sailer should not cross the Equator to the Westward of 25° W. in May. The captain of a smart ship, when outward-bound, may prefer keeping well to the Westward, and risking the detention near Cape St. Roque.

Ships bound to the Northward should cross the Equator between 25° and 30° W., thus avoiding the unsettled Wind and Weather near South America on the one side, and the large amount of Calm and light N.W. Wind in the Eastern half of Square 3 on the other. The diagram shows that the prevailing South-Easterly Wind is stronger, as well as more settled, between 25° and 30° W., than between 30° and 35° W., especially in the Southern part of the district.

June.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, where the wind is stronger than to the Eastward of them, and steer to the Southward in about 26° W., standing to the S.E. with the first of the Southerly Wind which they will probably meet with in 6° N., and keeping on the starboard tack, if they can make Southing, until they have made a fair amount of Easting. The Remarks on Wind, in Squares 302 and 303, show that ships should not cross the Equator to the Westward of 28° W., and it would be all the better if they crossed 2° or 3° to the Eastward of that meridian. Between 8° and 4° N. the prevailing Current will probably be Easterly, but South of 4° N. it is likely to be very strong to the Westward; the requisite Easting should therefore be made on getting the first of the Southerly wind, as the S.E. Trade becomes more Easterly near the Equator.

Winds.—Referring to the Eastern half of the June Wind Chart for Square 303, and taking S.E. by E. as a central point, then, when the Wind is not from that point:—

Between 0° & 4° S. the prob. is about 4 to 3 that it will be more Southerly.
, 4° & 6° S. ,, ,, 3 to 2 ,, ,,
, 6° & 8° S. ,, ,, 3 to 1 ,, ,,
,, 8° & 10° S. ,, ,, 2 to 1 ,, ,,

So that, as in May, the wind becomes more Southerly in the Southern than in the Northern half of the square, especially between 6° and 10° S.

Current.—The Westerly Current in Square 303 is still strong, especially in the Northern half of the square, where it frequently exceeds 30 miles in the 24 hours. There is much Southerly, and even South-Westerly, sea in June.

In cases of ships crossing the Equator, all those in Square 303 show the importance of crossing well to the Eastward.

Ships bound to the Northward should cross the Equator between 25° and 30° W., so as to avoid the unsettled Wind and Weather, which are more extreme near the South American coast than farther to the Eastward, and on the other hand to get a more steady N.E. Trade after passing 6° N. than exists farther to the Eastward.

July.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, where the N.E. Trade is stronger than to the Eastward. On getting the first of the Southerly Wind, in about 10° N., they should stand to the South-Eastward, making all the requisite Easting in the Northern part of the Southerly Wind as it draws more Easterly near the Equator. Between 10° and 4° N. they will probably experience an Easterly Current, but this will help them to windward, and place them in a better position for dealing with the very strong Westerly Current which prevails after passing to the Southward of 4° N.

Winds.—Referring to the Eastern half of the July Wind Chart for Square 303, and taking S.E. by E. as a central point, then, when the Wind is not from that point:—

Between 0° & 2° S. the prob. is about 2 to 1 that it will be more Southerly.
„ 2° & 4° S. „ „ 8 to 1 „ „
„ 4° & 6° S. „ „ 5 to 1 „ „
„ 6° & 8° S. „ „ 6 to 1 „ „
„ 8° & 10° S. „ „ 8 to 1 „ „

Showing that the Wind is much more Southerly than in June. The Wind is more Southerly in July than in any other month.

Current.—The Westerly Current in Square 303 is still very strong, especially in the Northern half of the square, where the mean of four or five observations is sometimes 35 miles in 24 hours! There is also much Southerly sea in July.

The Remarks on Wind, Square 303, give cases of ships which had crossed the Equator to the Westward of 30° W., getting hampered by the South American coast. The Wind is also much more squally and unsettled in Square 303 than in the squares to the Eastward of it, so that ships will do well not to cross the Equator to the Westward of 25° to 28° W. in July.

Ships bound to the Northward may be guided very much by the longitude in which they approach the Equator; those from the Eastward may cross between 20° and 25° W., as the Southerly Winds are slightly stronger on the Eastern than on the Western side of Square 3, but they should be in 25° W. when in 10° N., so as to get a better N.E. Trade than that which exists farther East. Ships from the Westward would do well to cross the Equator and stand to the Northward in about 30° W.

August.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, where the N.E. Trade is stronger than to the Eastward of them. On getting the first of the South-Westerly Winds in about 10° or 12° N., they should stand to the South-Eastward, not fearing the effect of the Easterly Current which prevails between 10° and 4° N., as a pretty strong Westerly Current may be expected to the Southward of 4° N. The diagram shows that the prevailing Southerly wind becomes more Easterly as the Equator is approached, so that the requisite Easting should be made with the first of the Southerly Wind; and as the Winds near Cape St. Roque are more Southerly and unsettled than they are farther to the Eastward, it is important to cross the Equator well to the Eastward, say in longitude 25° or 26° W., or even 2° or 3° farther to the Eastward.

Winds.—Referring to the Eastern half of the August Wind Chart for Square 303, and taking S.E. by E. as a central point, then, when the Wind is not from that point:—

Between 0° & 6° S. the prob. is about 2 to 1 that it will be more Southerly.
" 6° & 8° S. " " 5 to 1 " "
" 8° & 10° S. " " 2 to 1 " "

The Wind is still remarkably Southerly between 6° and 8° S., off the most Eastern part of South America.

Current.—The Westerly Current is still strong; strongest in the Northern half of the square. Southerly and confused swells are very frequent.

The Remarks on Wind, Square 303, give cases of ships that were hampered by the South American land; one, a fast iron ship, having crossed the Equator as far East as 27° 22′ W.

Ships bound to the Northward should avoid the South American land, as the Wind is lighter to the Westward of 33° W. than it is to the Eastward of that meridian. They should be in 25° W., or farther West, on crossing the parallel of 10° N., as the N.E. Trade is stronger and extends farther South on the Western side of the district than it does near the Cape Verd Islands.

September.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, where they will have a better N.E. Trade than to the Eastward. On getting the South-Westerly Wind in 10° or 12° N., they should stand to the South-Eastward; that Wind, with the prevailing Easterly Current, will carry them fast to the Eastward, but the diagram shows that to the Southward of 4° N. the prevailing Wind is South-Easterly, and the Current Westerly, which will carry them fast to the Westward.

Winds.—Referring to the Eastern half of the September Wind Chart for Square 303, and taking S.E. by E. as a central point, then, when the Wind is not from that point:—

Between 0° & 2° S. the prob. is about 3 to 1 that it will be more Southerly.
,, 2° & 4° S. ,, ,, 2 to 1 ,, ,,
,, 4° & 8° S. ,, ,, 3 to 1 ,, ,,
,, 8° & 10° S. ,, ,, 2 to 1 ,, ,,

Current.—The prevailing Current is Westerly from 20 to 30 miles in the 24 hours; the difference of its speed in the Northern and Southern halves of the square is not so great as in previous months. The sea is still very Southerly and confused.

The Remarks on Wind, Square 303, give cases in which ships were hampered off the South American coast, in some cases after crossing the Equator in 27° W.; so that it would be well to cross in 26° W., or farther to the Eastward.

Ships bound to the Northward are not likely to meet with North-Easterly Winds near the coast of South America; still it seems well that they should cross the Equator to the Eastward of 30° W., as the Winds in Square 4 are lighter than those in Square 3. The Eastern and Western sides of Square 3 seem to have equally good Winds for getting to the Northward, but it may be well for ships from the Eastward to cross the Equator in about 25° W., as the Winds are stronger on the Western than on the Eastern side of Square 39.

October.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, where the N.E. Trade is stronger than to the Eastward, and steer South until they meet the first of the Southerly Wind in about 8° or 7° N.; then stand to the South-Eastward until the Wind changes, so that they can make the most Southing on the port tack. The prevailing Current is Easterly between 10° and 6° N., but Westerly farther to the Southward.

Winds.—Referring to the Eastern half of the October Wind Chart for Square 303, and taking S.E. by E. as a central point, then, when the Wind is not from that point:—

Between 0° & 2° S. the prob. is about 3 to 1 that it will be more Southerly.
,, 2° & 6° S. ,, ,, 2 to 1 ,, ,,
,, 6° & 8° S. ,, ,, 4 to 3 ,, ,, E. or N.E.
,, 8° & 10° S. ,, ,, 4 to 1 ,, ,, ,,

Here, for the first time since April, it gets more Easterly or North-Easterly in the Southern than in the Northern and central parts of the square.

The Current is still Westerly from 20 to 30 miles in 24 hours, and stronger in the Northern than in the Southern half of the square. Southerly seas are very frequent in the Southern part of the square.

The Remarks on Wind, Square 303, give cases of ships crossing the Equator in 30° W., or farther West; all but the last were hampered by the land, so that 28° W. seems a safer limit in October, though the Wind Chart and Remarks show that the Winds near South America are more favourable for getting to the Southward in that month than they have been since April.

Ships bound to the Northward, whilst South of the Equator, will find stronger Winds between 25° and 30° W. than in any other longitude; after crossing the Equator they will find the Southerly Wind stronger, and the N.E. Trade stronger and more Easterly, in that longitude than they are farther to the Eastward.

November.

Ships bound to the Southward should certainly pass to the Westward of the Cape Verd Islands, for although the diagram shows that to the Southward of 16° N. the *prevailing* Wind is slightly stronger in the Eastern than in the Western half of Square 39, the amount of Calm is greater in the Eastern, especially between 14° and 16° N; and the mean force of *all Winds* is greatest in the Western half. After passing the Cape Verds, it may be well to haul slightly to the Eastward, so as to be in 25° W. when in 6° N., and then with the first of the Southerly Wind to take the tack which gives the most Southing, endeavouring, if possible, not to cross the Equator to the Westward of 29° W. A slight Easterly Current will probably be experienced between 10° and 4° N.; in other parts it is likely to be Westerly.

Winds.—Referring to the Eastern half of the November Wind Chart for Square 303, and taking S.E. by E. as a central point, then, when the Wind is not from that point:—

Between	0° & 2° S.	the prob. is about	5 to 8	that it will be more Southerly.
„	2° & 4° S.	„ „	equal	that it will be more Southerly, or Easterly, or North-Easterly.
„	4° & 6° S.	„ „	2 to 1	that it will be more Easterly or North-Easterly.
„	6° & 8° S.	„ „	5 to 1	„ „
„	8° & 10° S.	„ „	11 to 1	„ „

In November the tendency in the Wind to become more Easterly or North-Easterly in the Southern part of the square is very decided.

Current.—There is still a Westerly Current of from 20 to 30 miles in 24 hours, and sometimes it exceeds 30 miles; it is strongest between 2° and 4° S. The per-centage of South-Westerly Current is greater in the Southern part of the square than in previous months. Smooth seas are much more frequent than in previous months, especially in the Southern part of the square.

The Remarks on Wind, Square 303, give cases of ships which crossed the Equator in 30° W., or farther West. All, excepting the last two, made very fair passages to 10° S.; one, a dull sailer with light winds, whilst the other, though a fast ship, was very much hampered, but she crossed the Equator in 33° 50′ W.; so that a good sailing ship need not fear crossing in 31° W., if driven to do so by circumstances.

Ships bound to the Northward should cross the Equator between 25° and 30° W., as by doing so they will avoid the lighter Winds which prevail near the South American land on the one side, and also those which exist in the Eastern halves of Squares 3 and 39 on the other, beside getting a more Easterly N.E. Trade.

December.

Ships bound to the Southward should pass to the Westward of the Cape Verd Islands, where, although the Wind is much more Easterly than it is to the Eastward of them, it is decidedly stronger. On the Eastern side (between 14° and 16° N.) the Wind Chart of Square 39 shows that there is 15 per cent. of Calm. Ships should haul a little to the Eastward after passing the islands, so as to take the first of the S.E. Trade in about 25° W., or slightly farther East, then take the tack which gives the most Southing. The prevailing Current is Westerly throughout this route, and, as the diagram shows, averages 25 miles in 24 hours near the Equator, so that a dull sailer, which is not weatherly, should make rather more Easting before getting the S.E. Trade.

Winds.—Referring to the Eastern half of the December Wind Chart for Square 303, and taking S.E. by E. as a central point, then, when the Wind is not from that point:—

Between 0° & 2° S. the probability is about 8 to 2 that it will be more Easterly or North-Easterly.
„ 2° & 6° S. „ „ 2 to 1 „ „
„ 6° & 8° S. „ „ 8 to 1 „ „
„ 8° & 10° S. „ „ 6 to 1 „ „

In December the tendency to be more Easterly or North-Easterly than S.E. by E., when not from that point, prevails throughout the square.

The Current is still Westerly, averaging from 20 to 30 miles in 24 hours, and sometimes exceeding 30 miles; it is strongest in the Northern half of the square. There is still much smooth sea in its Southern part.

The Remarks on Wind, in Square 303, give cases of ships which crossed the Equator in 30° W., or farther West; they all had to tack off the land, and would no doubt have done better if they had not crossed to the Westward of 29° W. One ship was so hampered by Southerly Winds and Westerly Currents near South America that she stood to the North-Eastward, and *re-crossed the Equator* to make Easting, not getting to 10° S. before 25 days after her first crossing!!

Ships bound to the Northward should cross the Equator between 25° and 30° W., thus avoiding on the one hand the lighter winds which prevail near the coast of South America, and on the other the light Winds and Calms which are more common on the Eastern than on the Western side of Square 3. On the Western side of Square 39 the winds are very favourable for going to the Northward, but quite the reverse on its Eastern side.

We will now give a few extracts from the earlier information on this subject, which appeared in former editions of this work.

East or West of the Cape Verdes.*—With regard to this subject, the Royal Netherlands Meteorological Institute and the Meteorological Institute of Utrecht have done good service to the mariner in their excellent publications. The latter Office published a Table of the Times and Crossings of 455 Dutch vessels from the Channel to the Line. To this list the Americans added the sailings of 145 vessels, many of which were probably clippers, so that there was the experience of these 600 vessels to appeal to in the choice of the route in this part of the voyage.

Number of Vessels, Dutch and American, and their Average Time from the Lizard to the Line, by the passage East and by the passage West of the Cape Verde Islands.

	AMERICAN.				DUTCH.			
	EAST.		WEST.		EAST.		WEST.	
	Days.	Vessels.	Days.	Vessels.	Days.	Vessels.	Days.	Vessels.
December	29·5	4	27·0	4	32·1	11	33·6	16
January	28·5	3	31·5	6	31·5	17	31·0	17
February	27·8	2	28·9	11	35·3	9	32·9	11
Average and sum...	28·6	9	29·1	21	32·9	37	32·5	44
March	29·7	3	30·5	6	36·6	5	30·5	15
April	24·2	1	26·1	8	31·8	23	28·6	39
May	32·1	5	31·8	12	33·2	9	32·0	34
Average and sum...	28·7	9	29·5	26	33·9	37	30·4	88
June	36·7	2	29·7	17	32·5	4	33·1	37
July	34·5	3	30·6	9	35·5	4	33·9	53
August	30·2	2	34·5	11	35·4	4	33·8	38
Average and sum...	33·8	7	31·6	37	34·5	12	33·6	128
September	42·4	2	33·3	14	36·3	9	36·2	31
October	33·2	4	32·0	10	32·4	9	32·9	24
November	29·7	3	32·0	3	36·8	10	36·8	26
Average and sum...	35·1	9	32·4	27	35·2	28	35·3	81
Total average and sum	31·5	34	30·6	111	34·1	114	32·9	341

It appears that the passages East are uniformly longer for the Dutch, except in December, January, June, and October; and that for the American they give the shorter averages for January, February, March, April, August, and November. But the averages for these are derived from an insufficient number of passages, only two or three, fourteen in all, for each month.

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* It will be seen, in the previous remarks, that Captain Toynbee *in no month* recommends the route *Eastward* of the Cape Verdes.

There is a difficulty here in estimating the relative value of the American and Dutch results, as we do not know what the class and sailing powers of the two fleets were; but it is probable that the superiority of the American tracks would not be so great, if the Dutch had selected vessels of an equal class for the comparison. However, it would seem that there is certainly some few hours detention on the average by going inside the islands, compared with the outer passages contained in the foregoing Tables.

Captain Sir Edward Belcher, in his outward voyage round the Cape of Good Hope, in the *Samarang*, March, 1843, diverged from the "beaten track," with considerable advantage. His reason for so doing was, that by crossing the Equator 10° or 15° more Eastward than is usually done, when arrived in the parallel of St. Helena, he would be many miles to windward of the usual route. "Having always considered the Eastern route the preferable, I attempted, on my homeward voyage, in H.M.S. *Sulphur*, to reach Porto Praya direct from Ascension. In this, however, I failed, owing to the occurrence of Westerly breezes driving us toward the African coast, until in the parallel of the Cape de Verde Islands; which proved that from the Cape de Verdes, Southerly, towards the Equator, in the month of June, favourable breezes without calms might be reckoned upon; and I was reminded that ships coming from Ascension and St. Helena generally make good passages, passing to the Westward of the Cape de Verdes.

"My experience, while employed on the African station, taught me that a fair passage from the Cape de Verdes to Sierra Leone, or the coast Easterly, could always be anticipated, and that no retarding calms are to be met with on the verge of the African soundings. Vessels also from the African coast, seeking Ascension for change of climate, find this remark applicable; and it might be fairly assumed that if we could reach the Equator under light airs and moderate breezes in a less number of days than the average passage to 24° West longitude (the increased distance being impeded by many days' calm), and by crossing to the Eastward of 10° West longitude, the Westerly current would be avoided, and we should be able to fetch to windward of Ascension, or possibly sight St. Helena, many hundred miles to windward of the 'beaten track.' The result proved as anticipated. Leaving Porto Praya on March 7th, we experienced light and moderate breezes, with *South-Easterly current*. Between the 7th and 21st of March, or from Porto Praya to the Equator, on the ninth meridian of West longitude, we averaged 81 miles per day, and experienced no more than 10 hours calm. Before the South-Westerly breezes quitted us, we had been carried as far as 8° W. After light South-Westerly airs, we were enabled, on the 28th of March, by a succession of breezes from the S.E., to pass 150 miles to windward of Ascension, in 9° 44′ E., arriving in Simon's Bay on April 25th."—*Voyage of the Samarang*, pages 7-8.

This passage, which takes advantage of the Easterly Guinea Current (pages 325—334), will be more specially alluded to hereafter. If a West African port should be sought, of course the advantages are on the side of the inner passage.

As each portion of the passage over the Atlantic is, in a great measure, dependent on the other, it cannot be pronounced on absolutely whether, of itself, one part of a course can be most advantageously pursued in a certain direction. In the next ensuing paragraphs, this problem will be considered in connection with the further progress of the voyage.

Crossing the Equator.—As this question stood for some years, it was that to cross the Equator in 30° W. was the best route in all seasons. In 1848, Lieutenant Maury published his Wind and Current Chart of the North Atlantic, upon which he marked the Great Circle track joining New York and long. 31° W. on the Equator, distance 3,370 miles, and upon this track was the following:—"The distance by the route usually pursued is upwards of 4,100 miles. Outward-bound vessels are recommended to try this route to Rio Janeiro. The tracks of vessels on this chart show the average passage from the United States to the Line to be 38 days, and to Rio 55 days. There is reason to believe that the prevailing winds along the (Great Circle) route here indicated will be found more favourable—steadier and stronger than they are by the usual route, and the distance is nearly 1,000 miles less. Hence I respectfully invite the attention of navigators to this route, under the expectation that, by taking it, they will shorten their passage several days."

By the chart on which this note is placed, it seems that the practice of the American ships was to run down to Westward between 34° and 40° N., and cross the parallel of 30° between 30° and 38° W. Naturally, a better course would suggest itself, and the Great Circle course is that which would stand prominent. Captain Maury having received much encouragement by the adoption of an approximation to this track, to the great advantage of American voyages over the former Easterly track, argued strongly on the advantages that would be gained by the route from Europe being made to cross the Equator on the same meridian (about 30° W.).

Of the vessels mentioned in the table on page 493, the mean longitude of the American crossing is 26¼° W., while that of the Dutch is 22¾° W.; and yet the contrast between their passages is not so great as the difference in the position with regard to the Equatorial Calms or "Doldrums" would seem to warrant an inference. It may, therefore, be advised generally that the meridian of 26° W.[*] is a good crossing, and that, if farther West, it is questionable whether any advantage is gained.

In an able discussion of the logs of several clippers, in the "Mercantile Marine Magazine," the same conclusion is independently arrived at. "We have yet to learn if the most favourable crossing be *Westward* of 25° W. for English vessels outward-bound to the East. The passage *Eastward* of the Cape Verdes has been strongly recommended, and it is certainly worth attention that the best passage here recorded was made by a vessel (the *Lady Raffles*), which ran down her Southing Eastward of the Cape Verdes."

Captain Toynbee also discussed the Westerly crossing of the Line, as tried by him in his ship, the *Gloriana*. This voyage was made in October, 1858, and the Line was crossed in 30½° W.

"On the 2nd of October, 1858, the *Gloriana* was in lat. 17° 48′ N., long. 26° 29° W. From this position, being West of the Cape Verde Islands, *I endeavoured to make*

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[*] This has proved correct within 1°, as will be seen by referring to Captain Toynbee's remarks, given previously. His monthly routes are all between 26° and 28° W.

a true South course when the wind was fair, and preferred the tack which gave the most Southing when it was foul.

" From the 2nd to the 7th we went on well, for on the latter date we were in lat. 7° 29′ N., long. 27° 52′ W., having been driven by the wind and about 38 miles of current, 33 miles farther West. From the 7th to the 15th we had 'doldrums.' Until the 10th, when we were in lat. 6° 25′ N., long. 26° 57′ W., the weather was chiefly fine, with a mixture of Northerly and Southerly swells; after that, heavy rain-squalls, looking very threatening, but not sufficient wind to require the royals to be taken in, with a high Southerly swell. During the whole time the wind was from East round by South to West, but chiefly South; the current was generally to the Eastward from 11° to 5° N.

" Oct. 15th.—Lat. 4° 8′ N., long. 25° 41′ W.; current in the last 24 hours West, 16 miles; wind S. by W., by compass; variation 17° W. This was the point where I had to decide whether to steer to the Eastward, making a little Northing, until I considered my ship far enough to windward, or to the Westward, making about W.S.W., with the certainty of a Westerly current. I chose to go to the Westward, feeling sure that the wind would gradually draw to the S.E., whereas I think that, had we gone to the Eastward, we should have continued in the Variables, if we did not run back into Calms.

" Oct. 16th.—Lat. 3° 15′ N., long. 27° 22½′ W.; course and distance, S. 62½° W., 114 miles; current in the last twenty-four hours, N. 89° E., 12 miles; variation, by azimuth compass, 17° 3′ W., by steering compass, 16° 3′ W. At 10 a.m. a large ship passed us steering to the Eastward, and we lost sight of a barque which was in company, so I suppose that she also went off to the Eastward. The wind drew to the South by compass, so that we were able to make true S.W. ½ W. The weather during the last twenty-four hours looked unsettled, especially in the N.W., where there was lightning; but even when we broke off to W. by N. for an hour, I felt that, by going on the port tack, we were drawing into the S.E. Trade.

" Oct. 17th.—Lat. 1° 30′ N., long. 29° 24′ W.; by * lunar, 30° W.; course and distance, S. 48½° W., 162½ miles; current, S. 77½° W., 13 miles. The wind from S. by E. to S.S.E.; the sea smooth, and weather very delightful.

" Oct. 18th.—Lat. 0° 52′ S., long. 31° 24′ W.; by * lunars, 32° W.; course and distance, S. 41° W., 184 miles; current, S. 44° W., 12 miles. The wind from S.S.E. to S.E. by S.

" Oct. 19th.—5 a.m., lat., by meridian altitude of Sirius, 2° 32′ S.; noon, lat. 3° 15′ S., long. 31° 56′ W.; current, S. 13° W., 8 miles; wind, S.E. by S. ½ S.; bearing and distance of the Rocas, supposing them to be in lat. 3° 55′ S., long. 33° 44′ W., and taking the mean of the above longitude as my position at noon, S. 38° W., 51 miles. 3 p.m.—Lat., by meridian altitude of Venus, 3° 33½′ S. 3.20 p.m.—Long. by altitudes of the sun, using the London rates for the best chronometer, 33° 10½′ W. Hence, since noon we had made S. 36° W., 25 miles.

" Throughout the afternoon we steered about S. 35° W., and at 5 p.m. we saw the reef about 12 miles off, extending from nearly right ahead out on the weather bow; and at 6 p.m. we kept away W.S.W., so as to pass it at the distance of about 5 miles.

" The sighting of the Rocas was one of very many instances in my experience proving the look-out man, either from want of practice or from a want of interest in what he was doing, unable to see an object almost staring him in the face. From 3.30 p.m., I ordered a regular look-out from fore-topsail yard, and at 5 p.m. felt so sure that the reef must be in sight, that I determined to visit the topsail-yard myself; when, on stepping into the rigging, something strange caught my eye, which proved to be a beacon on the Western part of the reef; yet from the topsail-yard the look-out man had seen nothing, and could hardly see it when I pointed it out. A similar case happened one evening on our way towards Torres Straits, when I sent an officer up to look round as the sun set, though I always kept a man on the foretopsail-yard. He quickly saw a long line of broken water right ahead, it being part of Lihou Shoal, extending farther to the Eastward than laid down either in charts or books. I find that in moderately clear weather, when observations show that the land may be sighted, a good night-glass on the forecastle and a patent lead are first-rate safeguards; indeed, the three L's are all right enough, but much depends on the quality of these said L's.

"Now it remains to be decided how we should have fared if on the 15th we had stood to the Eastward, making Easting, with a little Northing, until we thought ourselves far enough to windward. In our present case we certainly had to tack off America (though it is the first time in my extreme Westerly routes that I have had to do so), yet in two days we beat 111 miles to the South and 27 to the East, and cleared the difficulty. It would not be right, however, to tempt ships near reefs and land unless they gain by it; and merely by a comparison of my own voyages of other years at the same season I should condemn this route, for I never did worse from 10° N. to the Equator than this year. Once at the very same date I passed between the Cape de Verdes and Africa. Then we were 13 days from 10° N. to the Line, but were not troubled near South America and had a better S.E. Trade. This time we were only 12 days, but lost a day near South America. In October, 1852, I passed 10° N. about 2° farther East within a day or two of our date, and was only 8½ days to the Equator, which we crossed in 20° W., having been carried into 18° W. by a strong S.W. monsoon, which turned into the S.E. Trade without a calm. Still, this probably was an exception, and I should like and shall try to see the logs of some ships which passed through the Doldrums with us.

"September 25th, 1856, and October 15th, 1857, I crossed the Equator much in the same longitude as this year—that is, 31° W.; in September passed 25 miles to the Westward of Fernando Noronha, and in October still nearer, and both voyages we weathered America with ease. Once in May I crossed the Equator between 28° and 29° W., and could not weather America, *but was much bothered off Cape St. Augustine.*

"Again, from Cape St. Augustine to the Abrolhos, the ships which pass far West do not seem to do so well as those which go far to the Eastward. For instance, as I am now writing on the 26th of October, we have done but S. 14° W. 51½ miles, and on the 25th, S. 23° W. 85 miles. For all this, one feels inclined to blame the Westerly route; at any rate until it is proved that the ships which went to the Eastward have done as badly or worse than ourselves.

"The conclusion I am inclined to draw from all this is, that in October, when once your ship is so near the Equator as to expect the S.E. Trade, and the wind sets in from S. by W. by compass, go on the port tack with the yards sharp up, and keep well full; then the wind is almost certain to turn into the S.E. Trade, with beautiful weather. My experience would lead me to say that in October, when you are below 5° N., with a steady S. by W. by compass wind, you have the commencement of the S.E. Trade, and should stand boldly on the port tack; but I am not yet quite decided as to how a ship ought to steer after passing to the Westward of the Cape de Verdes, though I think as we have done this year; that is, due South with a fair wind, and the tack on which you make the most Southing with a foul; because the probability is, that you will have a S.W. monsoon, which will drive you well to the Eastward. If there were not this probability I would have a ship in October steer to get to the S.E. Trade, or rather the S. by W. wind, in about 20° W., for if she does not get into the latitude of Cape St. Roque quite so soon, I think she will be in a better position by the time she loses the S.E. Trade." *

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* See the "Nautical Magazine," 1859, pages 169—177, and 561—563.

Captain Toynbee subsequently procured the logs from other ships of similar class which left the Channel at the same time as the *Gloriana*. The *Gosforth*, which was also West of the Cape Verdes on the same day, bore to the S.E., crossing the Equator in 25° W., and reaching 20° S. a week before the *Gloriana*. The *Alfred*, which pursued a similar course to the *Gloriana*, crossed the Line in 32¼° W.; and the *Vernon* and *Octavia*, which passed inside the Cape Verdes, crossed the Line in 25½° and 26½° W.

" The first question raised is—Was the *Gloriana* right in steering due South on the 2nd when the wind was fair? The *Gosforth's* track says no, she ought to have steered S.S.E. until in 25° W., and then to have made a little Easting with the Southing whenever it was possible. But the tracks of the two ships (*Vernon* and *Octavia*) which passed East of the Cape de Verde Islands, say on no account go to the Eastward of 22° W. This advice is only applicable when the wind is light and variable; of course, if a S.W. monsoon is experienced in these parts, a South-Easterly course must be followed until the wind draws to the South.

" On looking at these tracks I suppose Maury's correspondent, Captain Windsor, would say that the captain of the *Gosforth* is 'one of those men who are kicked through the world in good luck to keep them out of harm's way,' or how could he have had a run of 184 miles between the 5th and 6th of October, when ships to the right and left of him did but little more than half that distance in the same time? Not being a believer in luck myself, it seems to me that the little Easting he made from the 2nd to the 9th placed him in a position by which he was enabled to keep off the coast of South America, and so avoid the light winds from the 24th to the 26th which affected all the ships North of 20° S. Here my ***second query*** is answered, for we find that the Westerly crossing of the Line was not the cause of the light winds we experienced on the 25th and 26th; or, to be more explicit, the ships several degrees East of us suffered from them to the same extent as ourselves.

" The *Alfred* and *Gloriana* have given the extreme Westerly route a fair trial. They started from 20° N., differing one day in their dates, and on the 23rd of October, after passing Cape St. Roque, the *Alfred* was in the same position as the *Gloriana* had held on the 22nd.

" The extreme Eastern route between the Cape de Verde Islands and Africa was fairly tried by the *Vernon* and *Octavia*. It is manifestly wrong for the early part of October, for they lost much on the ships which took the Western route.

" Considering the positions of the four hindmost ships on the 28th of October, I am inclined to think that the *Gloriana's* is the best, for to get South of the Calms and Variables near the Tropic of Capricorn is more important than to make Easting, so much so, that, when there, I chose the tack which gives the most Southing. Hence the readers of my last paper on the subject will see that this research proves that we were better off than most of our neighbours, and no doubt the commanders of the other ships will examine this chart with great interest.

" It will be noticed that the *Gosforth's* track ends on the 21st, so that although, where it commenced, she was but a trifle more than half a day in advance of the *Gloriana*, she ended with an advance of seven days. Thus she gained on the *Gloriana*, 6½ days; *Alfred*, 7¼; *Octavia*, 8½; and *Vernon*, 9½ days.

" The conclusion I draw from this is, that early in October neither the extreme Eastern nor the extreme Western route is good. Therefore, a ship should pass West of the Cape de Verde Islands, and then when the wind will permit, haul to the S.E. when South of them, so as to be about 23° W. when she is 5° N.; she should then take the tack which gives the most Southing.

" Maury's 'Sailing Directions' support this opinion. The averages he deduces from the Table in page 148 of the 2nd vol., dated March, 1859, plainly prove that the extreme Western route is a disadvantage in October. And, again, the American part of the Table in page 869 shows that ships should not go East of the Cape de Verde Islands in October, though it is contradicted by the Dutch part of the same Table, with more ships to take an average from. Still, most of the nine Dutch ships may have passed East of the Cape de Verdes much later in October than the Americans; at any rate sound reason seems to support the middle route, for if a ship works her way to the South in the longitude of the Cape de Verdes she is more likely to get a spirt of the S.W. monsoon, which sometimes blows at this season, and avoid the certain Calms of a more Easterly course, as also the danger of being detained a day or two near Cape St. Roque by the more Westerly route.

" From the end of October to February I would pass East of the Cape de Verde Islands, and perhaps also in March and April. Early in December we took this route, and were on the Equator on the 23rd day from England.

" A few tracks similar to these for each month in the year would soon decide the best route."

We are unwilling to omit those instructions which appeared in our former editions, and which for nearly a century directed almost all the European shipping; but, of course, what has preceded will supersede them where they differ. Still, much is good to the present day, and may be followed advantageously.

M. D'Aprés de Mannevillette, in his Directions from the English Channel to the East Indies, says, "When you steer out of the Channel, you ought to shape your course so as to pass Cape Finisterre at the distance of 25 or 30 leagues; this distance," he adds, "will be sufficient, in whatsoever season of the year your voyage may happen; you may indeed double that cape still nearer, if circumstances require, but, from its latitude, you should always shape a course for the Island of Madeira.

" Though a sight of that island is not indispensably necessary in this passage, it is proper, however, to gain a sight of it, or of the Island of Porto Santo, that you may be able to keep on your course afterward with greater certainty, whether you pass between the Canary Islands, or leave them to the Eastward, as may be judged most convenient.

" In the passage from the coast of France to the Canaries, you may frequently find differences in your reckoning to the Eastward, which arise most probably from the indraught of the currents toward the Strait of Gibraltar: some have made the land on the coast of Africa when they expected to have discovered Tenerife; others have gained sight of Allegranza, off the Northern part of Lanzarote, instead of Tenerife; and, though the errors in reckoning may not frequently be so considerable, yet it is safer to be on your guard, when you judge, by your reckoning, that you are in the latitude of these islands, especially in the night-time, or when the want of moonlight, or very thick hazy weather, prevents you from discovering dangers at such a distance as to be able to avoid them.

" The differences to Westward, though much more rare, are not yet without example; chiefly when the winds have hung contrary for some time after the departure from the ports of England or France.

" Ships are, however, now generally recommended to pass to the Westward of the Canary and Cape Verde Islands; it having been found that, in this route, steadier winds may be expected than those generally prevalent close to or among the islands. On the African coast, W.S.W. and S.W. winds are frequent. The track now generally adopted by ships having chronometers is that to the Westward of all the islands.

"Should it be required to touch at Senegal or Goree, the best course will be to make the coast of Africa near Cape Blanco, lat. 20° 55′; as there are soundings at 5 or 6 leagues off the coast, and no danger in making the land, either by day or night, provided the lead be kept frequently going; and thus you may steer up to the cape.

"Though it may seem natural enough not to suspect any errors of consequence in your reckoning in so short a passage as from the Canaries to the Isles of Cape Verde, yet there are instances of such, as well to Easting as to Westing. It is with respect to errors in our Westings, that I advise all vessels to keep 30 leagues to windward of Bonavista, before they stand in to make the land; lest, in keeping a direct course for that island, they should pass between the Isle of St. Nicholas and the Isle of Sal; and, finding themselves to Westward of Bonavista, when they reckoned themselves to be still to Eastward of it, they should miss their refreshments at the Isle of St. Iago, an accident which has happened to several vessels.

"The making of these islands is often difficult, occasioned by the fogs which hang frequently around them. For this reason, those who come from the Northward ought to steer their vessels in this track with all possible precaution.

"The most convenient course for vessels which continue their voyage from the Canaries, without touching at the islands of Cape Verde or Goree, is to steer, after they lose sight of the Canaries, so as to pass about 45 leagues West of Cape Blanco, or near the meridian of 20°; from this position they will make good their course due South, as far as 12° N., and afterward S.E. by S., till they meet with those variable winds which succeed to the Trade Winds. By this they will keep the mid-channel between the islands and Cape Verde, and coast along the bank below that cape, at a sufficient distance, even though they should make an error in their reckoning of 15 or 20 leagues to the Eastward."

But as, when the sun is near the Northern Tropic, the Trade Wind has been often found to fail within the sight of the Cape Verde Islands, it has been recommended to ships, at these times, to pass the islands to the Westward, at the distance of about 10 leagues, in order to preserve a steady wind, and to prevent delay, by keeping clear of the light eddy winds, which then prevail near and among the islands. When to the Southward of these isles steer to the S.E., so as to get between the meridians of 18° and 23° W., upon losing the N.E. Trade Wind. Should the Southerly winds then commence, advantage may be taken of the shifts to stand on the tack which will gain most to the Southward, so as to cross the Equator between the longitudes above mentioned, if the wind will permit. Be cautious of making a long tack, either Eastward or Westward, with a dead Southerly wind, in the hope of having a better, unless the wind should veer, so as to produce much Southing.

The S.E. Trade Wind, at its Northern limit, generally inclines far to the Southward, particularly in July, August, and September, but frequently in other months. A ship meeting this Trade should not be kept too close to the wind, but keep clean full, in order to make good way to the S.W., and clear of the Southern limits of the Westerly current that generally prevails about the Equator.

It has been already shown, in the description of currents, that ships, passing the Line too far to the *Westward*, run the risk of not being able to weather the coast of Brazil. But M. D'Aprés has observed, that there is not one instance to prove that, by passing the Line to the *Eastward* of the limits above mentioned, ships meet with calms of long duration, and currents setting with great rapidity toward the River Gaboon, as had before been generally imagined.

M. D'Aprés adds, "Vessels which sail from St. Iago should steer S.E. as far as the 12th degree of latitude; after that S.E. by S. Those which depart from Goree should steer S.S.W., if they desire to keep clear of the coast, till they reach the parallel of 10°; thence their course should be S.E. by S."

His words on crossing the Line are, "When the Variable Winds succeed the Trade Winds, the best method of crossing the Line with speed is, to take advantage of the very first Variable Winds, for gaining the ordinary track of the Trade Winds, so soon as you possibly can; and for this end, to keep indifferently to that tack which bears most to the Southward, without troubling yourself about crossing the Line at any determinate point, lest you make your voyage longer than is necessary.*

On the Return toward England, in crossing the N.E. Trade Wind, a ship's sails should be kept well filled, to enable her to gain speedily to the Northward, as shown in the diagrams of Passages for each month of the year. In this track the Sargasso or Gulf Weed will be met with in the *Sargasso Sea*, as detailed on pages 335—343.

Beyond the Northern limit of the Trade Wind, ships generally cross the parallel of 32° N. in from 39° to 42° W., in order to make use of the Southerly and Westerly winds which prevail here more than they do to the Eastward.

Should the wind veer to the N.W. on approaching toward the Azores, you may pass through one of the channels of these islands, and thence pursue a course to the English Channel, according to circumstances.

It is not advisable to pass to the Eastward of these islands, because adverse winds often prevail from the Northward between them and the coast of Portugal; and the currents are also generally unfavourable to this route. Yet it has sometimes happened that ships passing this way have, with S.W. and West winds, reached the Channel sooner than those which have proceeded to the Westward. With these S.W. and Westerly winds, you must be cautious in approaching the Channel, in case the current should prevail which sometimes sets athwart it, as before described (255). In case of contrary winds, vessels bound to ports in the North Sea, &c., sometimes make a quicker passage by passing Westward and Northward of the British Isles, as stated on pages 466—467.

6.—TO AND FROM THE SENEGAL AND GAMBIA.†

Whatever may be the season of the year, it is advisable to gain an offing of 75 miles to the Westward of Cape Finisterre; from hence it may be immaterial whether a course be shaped to the Eastward or Westward of Madeira. A commander desirous of touching at the Canaries will adopt the former, and will shape a course for Teneriffe, having nothing to apprehend on this course but the Salvages, the position of which has been well determined. In the Canarian Archipelago the winds are mostly from

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* Captain Maury says;—"No sailing directions can be given for these Calm Belts, except such as are contained in these emphatic words:—MAKE THE BEST OF YOUR WAY ACROSS THEM WITHOUT REGARD TO LONGITUDE. To which may be added, that the nearer to North and South the course is, the better, as it crosses their direction at right angles.

† Abridged chiefly from the Baron Roussin.

North to N.E. If the course to the Westward of Madeira be adopted, a vessel will make the Westernmost of the Canaries only, and her position may be rectified by a sight of Palma or Ferro.

But a sight of the coast of Africa is by no means necessary for vessels bound to the Senegal or Goree. What has been said of the currents and prevailing winds in this navigation, leaves no doubt that it is perfectly useless to make the land more than 50 or 60 miles to the Northward of the Senegal, when bound to the Bar anchorage. This digression is the utmost which should be made from the above course; and by means of the lead, and some few latitudes carefully observed, it might even be made a direct one. On leaving Teneriffe, the course from its South point should be S.W. by S. as far as the parallel of 21°, then S. by W. ¾ W. as far as 20°, and from thence S. by E. ½ E. without any further alteration.

The first course will carry a vessel 85 miles from the nearest point on the African coast, and in a track where no danger has been found. The second will conduct her nearly 100 miles to the Westward of the Westernmost point of the Bank of Arguin. By the third she will make the coast in the neighbourhood of the *Marigot* or *Lagoon of Mosquitos* (lat. 16° 36½'), from whence she may coast the shore until abreast the Senegal.

If it be found necessary to make the land during the night, the lead, being the only means of correcting the estimated run, should be used frequently and with great care. At about 25 miles N.W. by N. from the Senegal, a bottom of white sand will be found, with 70 fathoms. From thence the depth gradually decreases towards the shore, and at 1 mile from it there is 7 or 8 fathoms. When in 15 fathoms of water, it is advisable to anchor until daylight.

There is a source of error attached to the navigation of the African coast, which must be carefully guarded against. It is the optical illusion caused by the great horizontal refraction, which renders any correct estimation of distance almost impossible. Numerous instances of it might be cited which would hardly be credited; therefore the moment the coast is seen, the lead only should be trusted to determine the distance from it.

Track from Senegal to Goree.—The *Almadies* of Cape Verde (described hereafter) are 94 miles S.W. ¾ W. from the roadstead of the Senegal, and the prevailing currents set nearly on that bearing; it is, therefore, the course to be steered from the Senegal to Cape Verde during the day; during the night steer a quarter of a point or more Westerly. From Cape Verde to Goree the course is direct; it is merely to coast the shore at the distance of 2 miles. From 5 miles off Cape Verde to Cape St. Mary, at the mouth of the Gambia, the direct course and distance are S. by E. ½ E. 93 miles, in all which space soundings may be found.

If bound to a port South of Goree, vessels should steer to sight Cape Verde, as the winds are fresher near the cape than at the islands. Hence the navigation is easy in the fine season, with the prevalent N.E. winds, but in the rainy season the S.W. winds make it difficult. After rounding Cape Palmas the land should be kept in sight, at a distance of 10 to 15 miles, and when 30 or 40 miles Westward of the destination the land should be approached more closely, to avoid being carried to the Eastward of the place.

Return to Europe.—The voyage from the Senegal to Europe presents no difficulty, and calls for no other precautions than those commonly used in long voyages on seas void of dangers. These precautions are, not to trifle with the wind, but rather to make a good run in a given time, than to endeavour to make good the proposed course. In all return voyages from places within the Tropics, the grand point is to leave the region of the Trade Winds and get into the Variables, and the currents setting to the Eastward, as soon as possible. As the winds generally blow from East to N.W. on the coast of Africa, from the month of December to the end of June, you should keep on the starboard tack until out of their influence. The course made good will be about N.W., and you will then be in the neighbourhood of the Azores. It is immaterial whether you pass to the Northward or through the channels of these islands, but it has been remarked that the winds are strongest to the Westward. It is seldom possible to pass to the Eastward of them; the distance, no doubt, would be shortened, but this passage can be effected only by keeping close to the wind thus far; and experience has proved that, by such procedure, little is to be gained.

7. REMARKS AND DIRECTIONS FOR THE NAVIGATION TO, AND ON THE COAST OF, WESTERN AFRICA.

WITH SOME ACCOUNT OF THE CURRENTS, SEASONS, ETC.; BY CAPTAIN THOMAS MIDGLEY, OF LIVERPOOL, 1837.*

On the Passage from England to the Western Coast of Africa, it may be well to make the island of Madeira and sail to the Westward of it if possible; for by so doing the ship will be placed in the best position as to her future course. After passing Madeira, steer so as to leave Palma about 70 or 80 miles to the Eastward (if nearer, the ship is liable to be becalmed), and then steer a course to make the N.E. end of Bonavista. Bonavista requires a good berth, as the currents about it are strong and uncertain, and dangers extend from the North and East sides to a great distance from the land.

In the winter, when strong Westerly breezes, of long continuance, prevail to the Northward, it may be impossible to make Madeira without much trouble and delay; in this case endeavour to get a good observation for longitude, or a sight of the Salvages; and should Westerly winds still continue, run boldly to the Southward. On nearing the Canary Islands, you will find the wind either gradually decrease to a calm, or it will veer to the Northward with heavy squalls. The squalls in this neighbourhood give little warning, but are frequently exceedingly heavy and dangerous. Any ship may very safely run through the passage to the Eastward of Palma, as a strong steady N.N.E. or N.E. breeze almost constantly blows through it; and by keeping mid-channel, there is little fear of being becalmed. When clear of the Canaries, a course may be shaped to make Bonavista, as before directed.

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* In these remarks, &c., by the late Captain Midgley, as in other parts of this volume, the courses and bearings are by *compass,* unless where otherwise expressed; and every bearing or direction of the Wind and Current is intended for the *true.*

The passage between the Islands and Cape Verde is generally and very properly adopted by vessels trading to the Western Coast of Africa; for, by running to the Westward of St. Antonio, they have again to make Easting in that tract of sea, which, lying contiguous to the Southern limit of the N.E. Trade Wind, is so often disturbed by calms, squalls, thunder, lightning, and heavy rain.

The currents between the coasts of Great Britain and the Cape Verde Islands are now so well known, that it is almost superfluous to make any further remarks upon them, excepting that their velocity is by no means exaggerated; and the dangerous effects which they have upon vessels, between the Bay of Biscay and the Capes Nun and Bojador, on the African coast, cannot be too strongly impressed upon the minds of those who have charge of valuable lives and property (see pages 319—320).

Those *passing Bonavista* in the months of June, July, August, and September, should not be too anxious to make Easting; for they will lose the Trade Wind soon after passing the parallel of the Island of St. Jago, and, after a short interval of calm, fall in with the S.W. wind and its usual accompaniments of heavy squalls and rain. On the further progress the vessel makes to the Southward and Eastward, the S.W. winds generally become variable to the Westward, and the squalls not so frequent.

At this season of the year it is advisable to give *St. Anne's Shoals* a berth of 150 miles to the Eastward, as the sea sets in so heavily upon the coast, between these shoals and Cape Palmas, that making Southing when near the land, in these months, is attended with much difficulty.

From October to April or May, the weather in this tract is generally fine, and the nights cool, beautifully serene and clear, with heavy dews; and in these months a more direct track may be pursued from Bonavista to the Southward and Eastward, than that above mentioned. In the influence of the Trades, the breeze is generally steady from N.N.E. and N.E., and the sea smooth, occasionally, however, interrupted by Tornados, which, in the neighbourhood of Cape Verga and Sierra Leone, blow with terrible fury. Such is their violence, that it is frequently necessary to keep the ship directly before them, under a foretopmast staysail only.

Between the Cape Verde Islands and the coast, the currents in the above tracks are variable, but mostly found running to the Southward, and seldom exceeding 1 mile an hour (generally from half to three-quarters of a mile), until hauling up for St. Anne's Shoals. At about 120 miles to the Westward of these, I have several times found them setting about E.S.E. by chart, fully 1½ mile in the hour.

The sea between the meridian of 20° W. and the bank of soundings extending from the African coast, is perhaps the most luminous part of the Atlantic Ocean. In the very dark gloomy nights of the wet season, with a strong breeze of wind, and when not one solitary star is visible, nothing can exceed, no pen can describe, the awful grandeur and magnificence of the scene. The whole surface of the sea appears as one vast sheet of liquid fire; and the ship, sailing at the rate of 6 or 7 knots through the water, causes streaks of light to be emitted from the sea, that throw a strong yet sickly and appalling glare upon all the sails, creating an indescribable sensation in the mind, that is very far from being agreeable, as the vessel appears to be surrounded by breakers on every side.

Although I have several times noticed this luminous appearance in the same track, I am led to remark more particularly upon it on account of a most awful night which I passed on the 24th of August, 1834, in or about lat. 7° 30′ N., long. 17° 50′ W., which left an impression upon the minds of all on board that I fancy will not be very soon effaced; for the vessel appeared to be sailing through a sea of liquid fire, whilst the heavy dark mass of clouds appeared to rest upon her mastheads, and not a single star was visible amid the horrid gloom. No bottom was found at 120 fathoms. Temperature of the air 82°, and of the water 79° (Fahr.).

Vessels in want of Kroumen should call at *Grand Sestros*. From some years' experience I can confidently say, that they are the most willing and best disposed men on the Krou Coast; and, if well used, are faithful to their employer in every difficulty he may have to contend with to leeward. Every vessel should take four or five, or more of them, in proportion to her size; for, in the Oil Rivers, if white men are exposed in the boats or canoes, landing or taking in casks, they very soon fall victims to the climate. The Kroumen prefer rice to any other diet, and a good supply can generally be procured at a cheap rate, except between January and June; but, considering the detention of lying-to, in order to procure it, the rice may be exported from England, for ships' use, at very nearly as cheap a rate. One of the Kroumen is of more real service in the Oil Rivers than two Europeans; they are generally well versed in the English language; and are contented with a *dash* or present when left at Fernando Po, after the vessel has completed her lading.*

On approaching the Krou Coast it is usual to hoist the ensign and fire a gun, and the vessel will soon be surrounded by canoes. A small canoe may be purchased for the ship's use for a mere trifle, and will be found extremely serviceable in the rivers.

The navigation between Cape Lahou and the land of Formosa presents no difficulty to the navigator; the currents in the route run to the Eastward at 1, 1½, and sometimes 2 knots or more, in the hour. If there be no inducement to call at Bereby, Drewin, or Cape Lahou, it will be as well (and will certainly expedite the passage) to shape a course from Cape Palmas for Cape Three Points; and then, giving that land a berth of 15 or 20 miles, shape a course for the land of Formosa.

In steering across the Bight of Benin, the current will be generally found running about 1 mile an hour to the N.E.; and must be allowed for, by steering one-third of a point to the Southward of the direct course.

A mere inspection of the chart will show that what is erroneously called Cape Formosa is, in fact, an elbow-land rounding off gradually to the Eastward; and regular soundings upon a muddy bottom extend for some considerable distance to the Westward and Southward of it. The land is here extremely low, and should not be approached in the night nearer than in 8 or 10 fathoms, unless by a vessel prepared to anchor.

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* Vessels now usually call at Sierra Leone for Kroumen, and it is uncertain whether the above remarks concerning Grand Sestros are still correct.

After making the land, the oldest and most experienced traders to the Oil Rivers are frequently deceived as to the position of their vessel; for the best description of the rivers from Formosa to Bonny is but vague and imperfect; and I therefore proceed to give such directions as I think, from my own experience, will be found useful to vessels bound to the Bonny or New Calabar Rivers.

The rivers between Terra Formosa and Bonny have all shoal bars at the entrance, and generally appear from the offing to be narrow. They have no peculiar feature to distinguish them, other than their being open to such points of the compass as are expressed in the Sailing Directions.

The Seasons here appear to have been imperfectly described. The rains generally commence in the latter end of May, or early in June, and gradually increase, with strong S.S.W. and S.W. breezes, during the months of July, August, and great part of September, towards the end of which month they as gradually terminate. In July and August heavy squalls frequently prevail; and in these months the wind very rarely shifts more than between S.S.W. and S.W., and the rain is incessant from sunset to nearly noon next day, when it ceases for a few hours, and again commences with more or less violence in the evening. In October the weather becomes more settled, with light land winds, and occasionally showers of rain, which, however, yield to the moderate sea breeze that sets in about 10 or 11 a.m. In November the Tornados commence, and are at first violent, gradually decreasing in strength as the *Harmattan* or *dry season* commences, although they are occasionally prevalent from this month to May. In December, January, and February, is the Harmattan season; and in these months the sea breeze sets in about noon, and blows with very moderate force from the W.S.W. and Westward until sunset, when it dies away to a calm. During the night there is little or no wind, and the weather is extremely sultry and oppressive, and very heavy and unwholesome dews. After daylight a light air springs up from the Northward or N.N.E., which gradually increases to a moderate force, and continues until about 11 a.m., when it falls calm, and soon after is succeeded by the light Westerly breeze. The Harmattan, however, sometimes blows steadily and without intermission from the N.E. quarter for several days together, especially about the new and full moon. It is at this season that the *smokes* prevail, and are exceedingly injurious to the European constitution. These smokes are so dense that it is impossible to see a cable's length from the ship for days together; and any vessels that may be in the offing, inward bound, have no resource but to anchor, and wait with patience for clearer weather.

In March, April, and May, the weather is clear, with light land winds at day-break, which gradually die away, are succeeded by the W.S.W. breeze about 10 a.m.; and this breeze blows with moderate force during the remainder of the day and greater part of the night. In these months the atmosphere is serene and clear, particularly during the nights, which —— very fine indeed.

The *Palm Oil* season commences in the early part of March; the oil becomes plentiful in April, and continues to be so until September, when it declines; and from October till March it is, properly speaking, out of season, although small quantities of it may be procured in these months.

In the foregoing remarks as to the season and climate, I beg to be understood as speaking of the New Calabar and Bonny Rivers only, and now proceed to consider the best means of preserving the health of the crews of vessels trading there. Masters of vessels should be on their guard against shipping plethoric or lusty men to go to the Oil Rivers of Africa. Drunkards are still worse subjects than these; for if a man undermines his constitution by intemperance in England, he cannot repair it in Africa. I have too frequently remarked that human skill is of little avail in saving the life of a drunkard when once attacked with African fever. The fact is, a drunkard is predisposed to sickness, and soon falls a victim to the climate. The plethoric or lusty man, if he has not tampered with his constitution, has a rather better chance; but should he fortunately recover from the fever, he is often annoyed with attacks of ague all the passage home, and does not recover until he arrives in England. Thin, raw-boned subjects are the best for the coast of Africa; selected from men who have made several voyages to the West Indies, as they are, in some degree, seasoned to a warm climate; those who have never made voyages to tropical climates should be decidedly rejected.

As a precaution for preserving the health of the crew, the vessel should be housed over as soon as possible after her arrival in the river. Plenty of mats should be procured, and a good, substantial, tight house be at once made, to shelter the crew, and preserve the vessel from the weather. Every care should be taken to make the house perfectly water-tight, as well for the comfort and health of the seamen, as for the advantage of working the palm oil in wet weather. An overstrained economy in the purchase of a few mats is highly reprehensible. The seamen will generally hang hammocks under the house; and, if well sheltered from the weather, will enjoy better health than they would by sleeping below in the steam emitted from the oil. In these rivers it is presumed that the Kroumen do all out-duty required in the boats, &c.; for a European should not be allowed to put his foot over the side, either for the purpose of visiting or going ashore, even on ship's duty (unless unavoidable), as it infallibly leads to dissension and drunkenness from the worst of spirits; and a drunken fit in Africa is the almost sure forerunner of sickness, and probably death.

All vessels should keep a sufficient quantity of English water on board for use in the country, as the Bonny and New Calabar water has an immense quantity of animalculæ, is very unpleasant to the palate, and injurious to health. Cocoa is an excellent and nutritious article of diet; and the crew should be well supplied with yams, which are the only vegetable, excepting corn and plaintains (the latter not plentiful), that can be procured in these rivers.

If the crew unavoidably get wet, they should immediately rub themselves thoroughly dry with coarse cloths, and put on dry clothes. The forecastle should be frequently cleaned out with a solution of chloride of lime (or other disinfectant), and the seamen's clothes and bedding kept well aired. Attending to these precautions will be found the best means of preserving health.

Here I may observe that fresh stock of all kinds is very scarce and very dear in these rivers, so that vessels bound to Bonny or New Calabar would do well by procuring their fresh stock and corn to windward, either on the Krou Coast, Frisco, Cape Lahou, the various settlements on the Gold Coast, or at a small village on the sea coast, near Cape St. Paul, called Dokko, or Occo (? Weh). At these places stock of all kinds is abundant, and very cheap when obtained in barter.

Current.—I had almost omitted putting the mariner on his guard against the effect of the strong Easterly current that runs from Terra Formosa to Old Calabar. This current runs with greater or less velocity almost throughout the year, except in or about the Harmattan season, when it occasionally sets to the Westward and W.S.W. Vessels that have advanced much to the Eastward of Terra Formosa, and cannot see Foché Point before night, should anchor, in order to prevent the effect of the current; but in squally weather, or the wet season, it may be as well to work to windward, heaving-to occasionally during the night, according to circumstances; a depth of 9 or 10 fathoms is quite close enough to stand inshore during the night; when in 6 fathoms the surf can be very distinctly heard.

When once to leeward on this coast, getting up to windward again is attended with much trouble and difficulty. I may here remark, that too much attention cannot be paid to the lead upon any part of the coast of Africa, as the current frequently sets directly in upon the land; and from careful observation, upon the Windward Coast, I can confidently assert that the thermometer is no guide whatever on approaching the land. In more than 100 experiments upon the *surface* water, I could never detect any sensible difference in the temperature when sailing toward the land from no bottom into 45 and 40 fathoms, and then into 14 or 15 fathoms, on the Krou Coast. In the dry season there is little difference hereabout in the temperature of the air and water; the former averaging 77° to 81° (in the shade), and the latter 74° or 75° Fahrenheit.

The Homeward Passage, through the Bight of Biafra, presents no particular feature to the attention of the navigator, if I may except the strong N.E. currents that almost invariably prevail in it. All homeward bound vessels that do not intend calling at Fernando Po, should use every possible exertion to pass to the Westward of the island, as a good board may be then made to the Southward on the starboard tack. Except in the Harmattan or Tornado seasons, no advantage can be derived by standing close inshore, as there are no land winds, and a near approach is, at any time, very dangerous, as the whole of the coast, from Camaroons to the Gaboon (except about Corisco), is generally bold-to, and the soundings in nowise to be depended on. On this part of the coast there is no trade, and the inhabitants are miserable naked savages.

On getting to the Southward of Prince's Island, the very excellent directions of Mr. Finlaison may be followed with advantage. He says:— "Having arrived at the Southward of Prince's Island, if the ship will lie no higher than W.N.W., tack immediately, and try to cross the Line; for, by so doing, you will keep out of the strong N.E. current (the *Guinea Current*) that sets towards the Bights of Benin and Biafra. After you have crossed the Line, you will find that you are nearly out of the Easterly current. In the parallel of 1° S. you will find the current set to the Westward, at the rate of 1 mile an hour. In the month of May or June, when the sun has a high declination, the Trade Wind is fair to the Southward, and you will not gain the regular breeze nearer than in 3° S. This breeze commences from S. by W. As you make Westing, the wind will be found to haul more to the Southward and Eastward, and the current increases to the rate of 1¼ knot an hour, until you arrive as far to the Westward as long. 15° W.

On proceeding hence towards Sierra Leone, come no farther to the Eastward than 15° W., until you are as far to the Northward as 8° 30′ N.; then you may steer boldly in for the Cape. You will strike soundings in that parallel, in 14° 40′ W.; and as you approach the Cape the soundings will be found very irregular, from 20 fathoms to 12 at a cast. You will then be 7 leagues from the Cape, and in the fair track of the river. Having given these directions to our prize-masters, they generally made the passage from Fernando Po or Bonny in five weeks; merchant vessels have frequently been three months by keeping inshore."

Many navigators have remarked, that on standing to the Westward between Prince's and St. Thomas's, even when making a trifle of Northing, the N.E. current has been found to diminish in strength as the vessel makes Westing. Even so far to the Southward as latitude 3° South there is seldom any Easting in the wind before passing the meridian of Greenwich.

Vessels bound to the Northward should not attempt crossing the Equator to the Eastward of 20° W. (the meridian of 21½° W. is to be preferred), and should then make a North or N. by W. course, to get into the N.E. Trade Wind, which having once fairly gained, the homeward navigation is generally well understood. In this route, after leaving the *Guinea Current* in the Bight of Biafra, the ship will gradually get into the *Equatorial Current* as she gets to the Southward, and this current frequently runs with considerable velocity. On examining my journals, I find that, by good lunar observations and an excellent chronometer, I have, at various times, made the following differences to the *Westward* of dead reckoning, in the run from St. Thomas's to longitude 20° W. of Greenwich, between the parallels of 0° 35′ North, and 3° of *South* latitude. In April, 1830, the brig *Anne* was set 237 miles to the Westward, and 78 miles to the Northward, of account, in 20 days. In October and November, 1831, the barque *Severn* was set 240 miles to the Westward, and 94 to the Northward, of account, in 23 days. In October, 1833, the *Freeland* was set 246 miles to the Westward, and 51 to the Northward, of account, in 20 days. In August, 1835, the same vessel was set 228 miles to the Westward, and 43 to the Northward, in 19 days; and in November and December, 1836, the *Caledonia* was set 373 miles to the Westward, and 107 miles to the Northward, in 18 days. But it may be observed that, in the latter vessel, I never crossed the Equator, but was generally 8 or 10 miles to the Northward of it, until I crossed the meridian of 12° W. In the above runs I have occasionally, but rarely, found slight differences to the Southward. When to the Southward of the Equator, abreast of the Bight of Benin, I have always found a current running at least three-quarters of a mile an hour to the Northward.

BY COMMANDER W. B. OLIVER, R.N.

Conceiving that a shorter passage by a sailing ship from the Bights, or Prince's Island, to Sierra Leone, than that made by proceeding to the Southward of the Line, might be made by keeping to the Northward, I determined to ascertain the fact; and though each time accompanied and retarded by a prize, made three unusually short passages, viz.—one from the River Bonny, anchoring at Prince's, and landing prisoners at St. Thomas's in eighteen days, the other two 13 days each from Prince's Island to Sierra Leone; and, on returning to England in H.M. schooner, unaccompanied by a prize; 39 days having been the shortest of three prizes I sent up under the old directions from Benin and the Gaboon. I issued different directions to prize-masters; and, although not acted on, in absence from myself, I feel assured they would have proved, as they did in my company, an improvement on the old one; a copy of which directions is as follows:—

Your first object will be to get to the Southward, unless you can make a West course (*true*) without any Northing; nor should you go to the port tack unless you can do so, or to avoid the land. Should the wind hang so much to the Westward as to prevent making a good course on the port tack, pass to the Eastward of Prince's or St. Thomas, or both, as you will sooner get out of the strong Easterly current, but do not approach the land within 20 fathoms, day or night, and get frequent casts of the lead.

When to the Westward of St. Thomas, and on or near the Line, steer W. ½ N., or W. by N.; according as your noon sights give you a Northerly set or not, until in the longitude of Cape Palmas, 7° 45′ W.; when steer, in the rainy season (May to September), about N.W. by N.; in the other months, N.W.; until in 13¾° W., the longitude of the Western limit of St. Anne Shoals; you may then make a true North course, sounding every 5 miles by night, or in thick weather, and every 10 miles by day, from 6° N. to 8° N. If you reach the latter without striking soundings, it will prove that you have passed to the Westward of St. Anne Shoals; when keep away E. by N., and you will make the high land of Sierra Leone; if by night, anchor on reaching 12 fathoms.

These instructions can only be acted on in a general way, as of course much depends on winds and currents; but I wish them to have full weight with any officer detached in a prize; and remember, the land about Sierra Leone should always be made to the Southward of the cape.

Sailing Vessels navigating on the Windward and Gold Coasts will, of course, be accelerated or retarded, according to the season. An able and competent judge on the subject has said :—

" *During the period of the year when land breezes alternate with those of the sea* (page 160), the best mode of beating a ship to windward is to get under way as soon as the wind blows steadily from the land, hugging the shore on board as near as may be prudent, for by that means every advantage is derived from it that can be expected. Soon after daylight this wind veers to the West, and lays the ship's head off shore; by 11 a.m. the sea breeze will have acquired its strength and true direction, at which time, also, the vessel will have made a good offing. Tack and stand in-shore, anchoring when in 8 fathoms of water, where it will be proper to wait for the land wind. By adopting this method, a vessel is placed in the best possible situation for taking early advantage of the breeze from the shore; whereas, if she were kept under weigh during the night, the probability is that she would lose all the ground she had gained the preceding day, independently of being placed where the land breeze might not reach her.

" *During the rainy season*, when the sea breeze blows both in the day and night, and at a few leagues from the shore from very near the South point of the compass, stand off shore for twenty-four hours, when the wind will mostly be found to blow at S.S.W. or S. by W., and often at South; with the port tack on board the vessel will lie up West clean full, and the variation being nearly two points Southerly, she will not only make good her course, but Southing also.

" As the current at this season of the year sets strongly to the Eastward, it will be prudent to allow about 36 miles in twenty-four hours for its mean velocity; otherwise, in bearing up and making the land, the the ship will be found to leeward of her port of destination. This is an error many have fallen into. Perhaps it would be better to allow even 48 miles, because it is easy to run to leeward, should the vessel prove to be to windward of the place to which she is bound."

8.—PASSAGES TO AND FROM THE WEST INDIES, WITH INSTRUCTIONS FOR NAVIGATING THEREIN.

The courses of sailing ships bound as above are regulated by the Winds and Currents which have been described in the preceding chapters. The consequence is they must take a circuitous track, not only to the West Indies, but to the Southern ports of the United States. For having passed Cape Finisterre, as before described, the best course is then to the S.S.W., so as to gain the Trade Winds quickly. The preceding observations on passing Madeira, &c., may, therefore, in this instance, be useful, as well as in the former.

As the great object is to attain the N.E. Trade, in order to run down your Westing with as little delay as possible, the remarks upon the passage across the Equator will apply almost equally to this voyage; the more especially those given by Captain Maury and Captain Toynbee as to a *Westerly* track from the Channel leading through steadier winds, and therefore more particularly applicable to the route across the North Atlantic in the Trades, where there is no object in maintaining an Easterly position to avoid being driven to leeward of the Brazilian coast.

In confirmation of this view, Captain George Cheveley, of Liverpool, remarks that he would recommend to ships clearing the English Channel, *if bound for the West Indies*, to make the S.W. quadrant, *true*, so as to pass nearly at an equal distance between Madeira and St. Mary's. Captain Cheveley adds, that, by pursuing this track, he invariably held a steadier breeze, and got much quicker into the Trades than when he proceeded farther to the Eastward, and so endeavoured to make more Southing. He is aware that the latter is the *general practice*, of which he entirely disapproves, so far as concerns a West India passage.

Ships for Jamaica generally pass to the Southward of the Island of Montserrat, and thence proceed for the high rock called Alta Vela, off the Southern point of St. Domingo, whence they take a departure for the Eastern end of Jamaica. When homeward-bound, they pass either through the Windward Channel or the Strait of Florida, as the wind and other circumstances may prevail or dictate.

Between the months of October and March, Northerly winds prevail over the Mexican Sea and the adjacent regions; and when Northerly winds prevail in the Strait of Florida, the Windward Channel must, of course, be preferred; but, at all other times—at least, generally at other times—the quickest, and, therefore, most eligible, passage is through the Channel of Yucatan, and thence, with the Gulf Stream in your favour, through the Strait of Florida.

Although the Windward Channel appears, by the chart, to be the shorter and readier passage, yet ships are frequently opposed here, both by wind and current, as will appear by the following statement, made by an officer already quoted:—"After the defeat of the French fleet, commanded by Count de Grasse, in April, 1782, and the British had arrived at Port Royal, in Jamaica, a squadron was detached to gain the Windward Passage, run down the Bahama Old Channel, and cruise to the Eastward of Havana, to prevent a Spanish squadron, in the harbour, from effecting a junction with the French ships that had escaped into Cape François (*Cape Haytien*). For six weeks did the English squadron beat against fresh sea breezes and a lee current; and, during that time, never advanced farther to the Eastward than off Morant Harbour, though the ships were much strained by carrying a press of sail to attain their object; but, after struggling so long, were compelled to return, baffled, into port. Now, though the first object might have been to meet the Spanish squadron on its way to Cape François, if it had sailed, yet, so soon as the effect of a lee current was ascertained, the object of gaining the Windward Passage ought to have been immediately abandoned, when, by bearing away with a favourable current for some distance, and before a fresh Trade Wind, Cape Antonio might have been passed the second day, the squadron have been off the Dry Tortugas on the third, and by beating along the Florida shore with a weather current, when to the Eastward of the meridian of Havana, it could have stretched over to Cuba in the night; and, in all probability, have gained the appointed station in six days, or even, perhaps, as soon as it could have gained Cape Maysi, if the Easterly wind had been moderate, and no current to contend with." *

When the Trade Wind blows strong, and in frequent squalls, during the summer months, between Jamaica and Hayti, and a short turbulent sea is found Eastward of the former, then will those bound for Europe or the United States shorten the period of their voyage by bearing away for the West end of Cuba, and passing through the Strait of Florida. For the strait presents a more eligible navigation in these months than the Windward Channel. The sea breeze will ensure a quick run to the Channel of Yucatan; and the current, perpetually setting Eastward between Cuba and Florida, will, in a few days, carry any vessel into the strait, where it will be nearly impossible to remain much above two days, in the strength of the stream, after being on the parallel of the Bemini Islands, even if there were not a breath of wind.

But as the North winds prevail in the Strait of Florida in October, and frequently during winter, when variable winds and strong land breezes are not uncommon on the coast of Jamaica, shipping will find this the most favourable period for gaining the Windward Channel. In January or February, if the wind offers a favourable opportunity for gaining the East end of Cuba, this track should be taken; but if the sea breeze be strong, the Strait of Florida should be preferred.†

When the sun has approached the Tropic of Cancer, strong Westerly winds begin to blow along the Western coast of Florida, and prevail during the months of June, July, and August, from the Bay of Apalaché, South-

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* "I think that this paragraph, unless qualified, is calculated to mislead; particularly in the words, 'when, by bearing away with a favourable current for some distance, and before a fresh Trade Wind, Cape Antonio might have been passed on the second day.' Admitting the general experience of the writer of this passage, I think he states an extreme case. The distance from Port Royal to Cape Antonio is 518 miles; which (divided by 48) equals more than 10½ miles per hour. Generally, there would be nothing extraordinary in this performance, but I much doubt if it be often accomplished in the locality alluded to, at the time of the year supposed; viz., in the middle of May. In that month of 1833, I was ordered from Montego Bay to New Providence; at the former place I consulted some of the most experienced commanders of West Indiamen, whether the most eligible course would be that of Cape Maysi or Cape Antonio; the majority recommended the latter, and I more readily deferred to their advice, from its concurrence with that contained in the extract, the previous consideration of which had occupied my mind.

"Finally, although the advice contained in the extract above is judicious in establishing the advantages of the Leeward Passage, I repeat, that the hopes of making it so speedily as is represented will not often be realized, for neither very favourable currents, nor fresh Trade Winds, will be experienced upon that track at the season indicated; nevertheless, there is the all-important distinction between the passages of *certainty* and *uncertainty*."—*Lieutenant W. H. Brady, R.N.*

† In sailing for the Windward Channel, get the coast of Hayti on board as soon as you can, as you may then find a windward current, and, in the evening, the wind off shore.

ward. These Westerly winds cause fluctuations in the atmosphere, which prevail more about the Western end of Cuba than farther Eastward; and near Havana they have little influence. At this season, vessels from Jamaica have met a Westerly wind in the Channel of Yucatan; others have experienced a fair breeze at some distance after passing Cape Antonio; and the wind here will be found sometimes at N.W., West, and S.W., veering about variably.

The wind in the Eastern quarter sometimes fluctuates about the Western end of Cuba, but not generally.

At this season the wind blows impetuously off Jamaica, and in frequent squalls; and sailing vessels bound thence to Europe should universally prefer the Leeward Passage. They will probably pass through the Strait of Florida before they could gain the entrance of the Windward Channel, though straining, with every effort, against the wind. The *appearance* of a favourable opportunity for passing through that channel should not be suffered to deceive; for it may be no indication of the general state of the wind Eastward.

From the West Indies to the English Channel.—After having cleared the Strait of Florida or Windward Passages, vessels may pass either to the Northward or Southward of the Bermudas, giving the islands a good offing, and attending to the preceding remarks on the currents, &c. In summer, the track to the Northward of these isles has been recommended, passing thence to the Northward of the Azores. In winter, the track to the Southward of the Bermudas is to be preferred; because, in this season, gales of North-Westerly wind may be expected from the coast of America; and, therefore, vessels should continue a little to the Southward of lat. 30°, or in about lat. 29° 40′, if wind permits, until certain of being to the Eastward of the Bermudas; nor should they run to the Northward of lat. 35° or 36°, until within a few degrees of the Azores. Thus will the heavy gales be avoided, which frequently rage more to the Northward.*

In shaping a course at any season, it should be remembered that the Great Circle course from Cape Florida to the Lizard follows the outer edge of the Gulf Stream in its earlier course, and passing about midway between the Bermudas and Cape Hatteras, it bears away North-Eastward over the tail of the Newfoundland Banks, and reaches the parallel of Scilly on a due Easterly course. The vertex of the Great Circle being in lat. 50° and long. 13° 48′ W., of course its direction is nearly East and West for several degrees on either side of this point. The shortest distance between Cape Florida and the Lizard is 3,671 miles. It leaves the Strait of Florida on a nearly due N.E. course *true* (N. 45° 35′ E.), and reaches the Channel on an E. ½ S. true course.

During a great portion of the year, it is probable that this course could be strictly followed to advantage. Of course, the consideration of meeting with Cyclones, which follow very nearly this Great Circle course toward the N.E., is important, and therefore during their season, July to October, as shown in (161), on page 223, a more Easterly route had better be pursued, that is, if the Florida Channel be taken; but if, as is more probable, the Windward Passage is taken in this season, the Great Circle course thence will be the most advantageous.

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* As the most destructive Hurricanes on record, in this part of the Atlantic, have occurred in the vicinity or on the borders of the Gulf Stream, this is an important reason for ships from the West Indies, bound to Europe, not to advance too far to the Northward. See further remarks on this subject, attached to the description of the Azores Islands hereafter.

But upon this subject Major Rennell has said, "Notwithstanding the advantages to be gained, in point of distance, by ships returning from the West Indies by the favouring current of the *Gulf Stream*, which may be perhaps reckoned equal to several days' sailing; yet experienced navigators are still of opinion that, on the whole, it does not present equal advantages with the Southern route.

"It was, until latter times, held as a maxim not to advance to the Northward of the parallel of lat. 33°, in returning from the West Indies, because of the prevalence of storms Northward of it. This wise rule of our ancestors has again been taken up, and His Majesty's ships, and of course convoys, will be, in future, directed to proceed by the South of Bermudas, and to cross its parallel at a few degrees to the Eastward of the isles, and thence to steer direct for Corvo.

"But, it may be observed, that a track which should cross the parallel of Bermudas at a *very few* degrees to the Eastward of it, and then lead directly toward Corvo, would cross a most critical portion of the space, in which several gales have been actually experienced. Therefore, it would seem that the parallel of the Bermudas should not be crossed at less than about 15° (or say 14°) to the Eastward of the islands.

"But, it may be asked, Where is the necessity of going to Corvo or Flores at all, for by it ships are placed in a situation proverbially known as a place of storms; that is to say, on the West and N.W. of the Azores? Why not go between *them* and the *greater Azores*, or rather to the Southward of them all, and thereby pass through a kindlier climate at all times?

"Any calculations or comparisons of time in making the different passages would be nugatory, since the security of lives and property is the main object; but it even happens that ships, which have had all the advantage of the Gulf Stream, have been crippled, and made more delay than in the Southern passage with adverse currents."

We are indebted to Captain E. J. Sharpe, of the steamer *Carib*, who in 1890 wrote to us as follows, on this subject:—

"Now we come on very debatable ground, and that is the best track home from the West Indies. The Admiralty Pilots and general practice, all recommend the Southern route, and it almost seems like presumption on my part, when I state I entirely differ from them. My experience is that the Northern route, when carried out in conjunction with the Pilot Charts, is much to be preferred, passing through a region of fair winds and favourable currents, facts not to be despised in a slow steamer or a sailing vessel. And again, as ships are now so much stronger built than formerly, the little extra wear and tear is nothing in comparison to the shorter distance, and the shorter time gained by the ship making better runs. Again, if bound to the English Channel, how much better it is to enter on a parallel than obliquely, in thick weather."

ROUTES FOR SAILING VESSELS BETWEEN NORTHERN EUROPE AND THE SOUTHERN PORTS OF THE UNITED STATES, THE WEST INDIES, ETC., BY CAPTAIN MAURY.*

Get your offing, and proceed as though you were bound to Rio, until you get into the N.E. Trades. Then steer West until you fall in with the track of homeward-bound Rio traders, and then take that.

Shipmasters, bound as above, should study the Wind Chart carefully, in order to ascertain the extreme Northern parallel near which they may rely upon finding the N.E. Trades. The limits of these for the month should then be marked on the Chart for every-day reference and use. Having reached the mean Polar limits for the month, it will, as a rule, be wise to go 2° or 3° farther South, in order to be sure of a good time in "running down the Trades."

Having reached the parallel of 30°, between 20° and 25° W., the best course is still a little to the West of South, until the parallel of 20° N. be reached. Do not care to make more than 5° of Westing between these two parallels. From 30° N. to 20° N. by this route, the average time will be six days in fall and winter; five in spring and summer; thus putting you fairly within the Trades in eighteen days, on the average, from the Channel. It will be less from Lisbon, the ports of Spain, and Gibraltar.

Now, suppose you enter the Trades at a mean between the meridians of 25° and 30° near the parallel of 20°, you should then "run them down" on that parallel to 60° W. It will take two weeks to do this; total, so far, from the Channel, 32 days. Arrived here, you are in the fairway of homeward-bound Indiamen and Rio traders; and from this point every navigator knows the way to his port. If it be on the Atlantic, South of the Chesapeake, 10 days, on the average, will put him into it—total, 42 days from the "chops" of the Channel, and from Liverpool a day or two more, from Spain and Portugal a day or two less, to our Atlantic ports. By this route Savannah is brought nearer than Charleston; and Fernandina made, for the voyage *from* Europe, our nearest Southern port. If, on the contrary, he be bound into the Gulf, it will take him 15 days, from the homeward-bound Rio track, to put him into New Orleans or Mobile—total to Gulf ports 47 days. These times are for ordinary sailers. A smart ship, with a smart captain, will always make the run in less time.

This is a mere general sketch of the average route. Clever navigators will know from the charts how to vary it according to the season, and smart ships will gain upon the time, especially in reaching and "running down the Trades."

The sketch supposes the ship to enter the Trades near the intersection of the meridian of 25° with the parallel of 20° N. There is no particular advantage in entering the Trades either on that meridian or upon that parallel, or of entering them at all, if you happen to find good winds before you get to the Trades.

Thus, suppose a vessel to be off the Lizard, bound to Charleston, and that she have a 7 or 8 knot breeze that will enable her to lay up direct for port; why should she, as long as that wind lasts, run out of her way to find one that will not enable her to do any better? On the contrary, let her take advantage of it to make Westing as fast as possible, and when it grows lighter or becomes adverse, as it will, then let her master stick her away South in search of a better wind.

By doing this, the voyage, as I have sketched it, may be considerably shortened. The Wind Chart will show the navigator exactly how far South he ought to go to look for the Trades in each month. A reference to this, with the injunction to make the most of a good wind wherever he finds it, seems to be almost the only sailing directions that are required for the ports above named, especially in winter and spring.

In the fall of 1856, Captain Macloon, of the *Georgia*, asked to have pointed out to him a better route from Liverpool to Savannah, stating that he had tried three, and had had by them two passages of 60 days each, and one of 54. The reply from Captain Maury was, in substance:—

"You ask for a new way to come from Liverpool to Savannah. I have often thought that if I were in that trade, considering the passage is a long and tedious one, I should try it on the Trades; that is, when you come out of Liverpool, proceed as if you were going to cross the Line (for which you will find sailing directions at page 475 *et seq.* of this work). Aim to cross the parallel of 30° N. in about 25° W., and then steer S.W. till you get well into the Trades, even if you have to go as far as the parallel of 20° N. Now steer West till you get about the meridian of 60°, and then haul up for your port. If you have a smart ship, and will try this passage next November, you will make something like this run:—From Liverpool to the parallel of 30° N., 14 days; thence into the Trades, say 22°—20°, 5 days; thence to the meridian of 60°, 10 days; thence to Savannah, 7 days; total, 36 days.

"Within that time this passage *can* be made by this route; but as I suppose the *Georgia* is not a clipper, I will give you a week longer, or 43 days; and if you not make it in that time, I shall be disappointed."

From June to October, inclusive, there is not much choice of routes. On the one hand the N.E. Trades are uncertain at that season of the year—the Hurricane season; while to the North calms are most prevalent, and gales less frequent. During these months, therefore, the best route is the straight course, for the Atlantic ports especially, taking advantage of the winds as they present themselves, for they are too unstable for one to go either to the North or South to look for them.

At this season of the year the Calm belt of Cancer is far North and vessels that attempt to make Westing between 28° and 34°, will find the winds more baffling than they will either to the North or the South of those parallels. I caution navigators to avoid the belt between these parallels as much as possible; and when they *have* to cross it, I advise them to cross it nearly on a meridian. The Wind Chart shows the position of this Calm belt for each month.

Transient vessels, bound into Philadelphia and New York, would find the Southern route, in the winter months, the most desirable, on account of the weather, but the passage by it would, at that the most favourable season for it, be prolonged about a week on the average. The mistake that has been generally made by vessels taking the Southern route is in their not going far enough South to get well into the Trades. The Wind Chart will leave no one in doubt upon that point, and no vessel attempting the Southern route should think of steering North, whatever be her port, until she falls into the great track followed by the homeward-bound vessels from the other hemisphere. They cross 25° N. in about 65° W.

Dull-sailing passenger ships from the North of Europe would do well, especially from December to March, inclusive, by taking the Southern route, even though they be bound to New York. If they cannot gain time by this route, they will gain at least smooth water and pleasant weather until they reach the offings of our own coasts.

In summer, the Great Circle route is the best to all the Atlantic ports. Even for the Gulf ports and Cuba the route in summer time should be decided upon according to the wind one meets with while gaining an offing from Europe, rather than by considerations growing out of any fancied preference as to winds by the way. If they be such as to force you to the South, make as much Westing as you can before crossing the parallel of 38°. Having crossed that parallel, it is then advisable to go South in search of the N.E. Trades to carry you into the Gulf.

The reason why the North or Great Circle route is recommended to vessels bound to any of the Atlantic ports during the summer and fall months, from May to October, inclusive; the reason why no preference is given to the Southern route over the Great Circle during that period, even for Gulf-bound vessels; and the reason why such decided preference is given to the Southern route, from December to March; may be gathered from a little reflection as to the course of the Trade Winds, and careful consideration.

From December to March gales of wind are most frequent along the Northern route. These are mostly from the Westward. This circumstance, therefore, is against the Great Circle route in the winter time. But from May to October the case is different. The gales along the Great Circle are much less prevalent.

On the other hand, the Trade Winds being a flow of air from colder to warmer latitudes, the difference of the temperature between the Calms of Cancer, from which, and the Calm belt of the Equator, into which the Trade Winds flow, is greater in the winter than in the summer time; consequently the more rapid, constant, and steady is the winter flow.

In the summer, however, the air in the Calm belt of Cancer, though it be as far North as 35°, attains as high a temperature, especially on the continents of Africa and America, as it does in the belt of Equatorial Calms. Then why should not the air flow towards those continental heated places as well as to the Equator? It does; and thus the Trade Winds are frequently broken up in the summer time, and therefore they cannot be relied on as in winter. There is another reason why the winter Trades should be fresher, more steady, and constant than the summer Trades, and it is this: In the winter time the Calm belt of Cancer, out of which the Trade Winds flow, is some 500 or 600 miles nearer than it is in the summer to the Equatorial Calm belt into which the Trade Winds blow—the places of high and low barometer are then closer to each other;

and no one engaged in the business of commerce need be told that the closer the places of demand and supply be together the more certain and steady will be the supply.

And there is also another reason why the Southern route, even by the Gulf-bound ships, should be abandoned, and why the Great Circle route should be preferred, in the summer time, which is this: From July to October the Hurricane season rages in the West Indies, while from June to October the gale charts show the Great Circle route to be the least stormy.

The remarks about the Southern route, for vessels bound in winter as far North as the Chesapeake and New York, are intended especially for the passenger ships from Bremen, Hamburg, and other ports in the North of Europe, and they are earnestly commended to the attention of the masters of such ships.—*Maury*.

In the diagram of Passages, the routes recommended for each month of the year are shown graphically, and will be readily understood.

DIRECTIONS FOR SAILING TO AND FROM THE WEST INDIES AND NORTH AMERICA, TRANSLATED FROM THE "DERROTERO DE LAS ANTILLAS," BY CAPTAIN LIVINGSTON.

These advices, or directions, are simple applications of a principle derived from the general prevalence of the Winds and Currents, as already described, as will be seen by a reference to the diagrams.

Were it not for the constant wind from the Eastward, which reigns within the Tropics, it seems likely that the maritime commerce by sailing vessels between the two hemispheres would never have existed; for, by its means, not only are the voyages rendered very simple, which would otherwise be interminable, but people in the most distant regions communicate with facility; and thus the navigator who is bound to the Westward has only to place himself within the limits of the Trade Wind, in the certainty that, in this manner, he must effect his purpose in the shortest possible period. Such is the *first rule*, which ought always to be attended to for this navigation.

The *second rule* is derived from the first; it is, that any one, bound to the East from the West, ought to get out of the region of the Trade Winds into that of the Variables or Anti-Trades.

We have here the two precepts which direct the operation of navigators in extensive seas; and in attending to them we shall observe, that every one bound from the Peninsula (Spain and Portugal) to the Eastern coasts of America, ought to get into the Trade Winds as soon as may be, holding in mind a recommendation, which may be considered as a precept, that is, *never, in navigating extensive seas, to keep close-hauled, but always take care to sail with the wind free; or at least to keep seven points from it.*

Taking it as granted that the first care of every one bound to America ought to be to get into the limits of the Trade Wind, it is clear that, with scant winds, the tack in the third quadrant (S.W.) will be most advantageous, and ought to be followed always when it can. All the endeavour ought to be to get into these winds, without being particular as to the means, and without keeping close to the wind to pass between the coast of Africa and the Canaries; but taking the passage that suits best, be it that between the Canaries and Madeira, or that between Madeira and the Azores; and certainly either of these is preferable to that to the East of the Canaries, for the proximity of the coast of Africa deadens the wind, and, consequently, is unfavourable to the brevity of the navigation.

Having gained the Trade Winds, the navigator must take precautions conducing to prevent any error of situation, in making his port of destination; for, if he who navigates by observations is exposed to be even 30 miles in error, he who has no more than dead-reckoning to direct him may, probably, be 6 degrees wrong. It is very necessary to guard against this error; keeping in view that, in proportion as it will be easy for any one, making a landfall to windward of his port of destination, to run down to it; so will be the difficulty, if he makes the landfall to leeward of his port, in beating up again in a sea wherein both the winds and currents are contrary. Even if bound to the coasts of the United States of America, it will be advisable to run into the limits of the Trade Winds, in order to get to the Westward in as short a time as possible; and although this mode may appear long, on account of having again, after crossing, to augment the latitude, it will be sufficient to keep in view the following maxim, to convince any one to the contrary:—*If in the one way the distance is shorter, in the other the velocity with which the ship proceeds towards her port of destination more than balances it.*

There are, nevertheless, many occasions on which a vessel may run across to the American coast without reducing her latitude, and these occasions may be frequent in the forty or fifty days which follow the two Equinoxes, as epochs during which the N.E. winds generally prevail; therefore vessels which make their passages at these times, may at once follow their voyage in high parallels, without descending to low ones.

In summer, as the region of the general or Trade Winds extends to about lat. 28° 30′ N., it follows that the round-about is trifling; and this circumstance ought to be attended to in the calculations which every captain of a ship should make before he fixes on the course he will pursue.

Recapitulating what we have said about the course which is most advisable for crossing to the United States, from the coasts of Spain, it follows that, if the wind permits it, West is the preferable course; and, in case the winds will not allow of shaping that course, the most advisable track will be that which comes nearest to it, if the voyage is made at the times above mentioned after the Equinoxes; but if at any other time, a course in the third quadrant (S.W.) should be preferred; for this will carry the vessel soonest into the Trade Winds, with which the necessary longitude may be quickly gained.

Vessels bound to Cuba during the rainy season, or season of the South winds, should pass to the Northward of Porto Rico and Hayti; but during the Norths they ought to go to the Southward of these islands. The ports chiefly frequented are, St. Iago on the South, and Havana on the N.W.

If bound to the first, it is necessary, in whatever season, to proceed directly to it; that is, in the season of the Norths, to steer from Cape Tiburon, to make some point on the South of Cuba to windward of the intended port, or even to windward of Guantanamo; and in the season of the Souths, to steer from the Point of Mole St. Nicholas almost West for the port, marking, in the first instance, various points on the coast of Cuba.

If bound to Havana, in the time of the Norths, you should pass to the Southward of Cuba, although you will have to return the distance between Cape Antonio and Havana; because this inconvenience is not comparable to that which might be occasioned on the North side of the island by a hard *North,* which would not only expose a vessel to heavy risks, but might protract the voyage much longer than the course above described, because the distance in the latter case may be worked up in a short time.

From St. Iago de Cuba, as the coast is clear, a vessel for Europe may easily make her way by the Windward Passages, while all those which are bound from Havana will take the Strait of Florida.

By the *Strait of Florida* we understand the space included between the meridian of the Dry Tortugas and the parallel of Cape Cañaveral. The simple inspection of the chart will show this to be a bed or course, which, like a river, conducts the water to the Northward. This river, the Gulf Stream, flows first to the E.N.E. as far as the Western meridian of the Double Shot Kays, by which Kays the stream is diverted from E.N.E. to N. by E., the direction which it pursues on the parallel of Cape Florida; thence to Cape Cañaveral it runs North, with something of an inclination to the East.

As it is undoubted that this general current is caused by a superabundance of waters, which seek, by this drain, to regain their level in the open ocean, it follows that its rapidity will be greater or less, according to the said superabundance of waters; but as a change cannot be momentary, on account of the great reservoir in which the water is contained, but progressive, and of course slow, we hold that, having once ascertained the velocity of the current, we may calculate it for three days or more in advance without much error, if the wind remains in the same direction; for an alteration in the wind may affect the force of the current considerably, as already explained on page 394.

On the meridian of Havana strips of current are, at times, found setting to the E.S.E. and S.E. from the Tortugas Soundings. Care should be taken not to confuse the Southern differences, caused by this branch of the current, with those caused by the eddy current near the Colorados—the one giving Eastern departure, the other West. The distinction is very clear, and can admit of no doubt, because the eddy current is met only from the meridians of Cavanas and Bahia Honda to Cape Antonio, and not farther out from the coast than the parallel of 23°.

As the velocity of the current varies, it is requisite for every navigator to ascertain its strength as frequently as possible, while within the Stream. Every one who enters this channel, having marked well either the lands of Cuba or the Florida Reef, so as accurately to establish this point of departure, ought to determine, in his *first day's* work, the velocity of the current by the difference of latitude by account and observation. We say during the first day's work, because the generality of common navigators make use of meridian altitudes of the sun alone to find the latitude; but it is very clear that *altitudes of the planets and fixed stars ought not to be neglected; not only because by this you cannot be in doubt of your real latitude, but also, because they may be more exact than latitudes deduced from meridional altitudes of the sun, when that luminary passes in the proximity of the zenith, and because repeated observations during the night assure, as much as possible, the situation of the ship.* Thus you may go on, with a clear idea of the operation of the current, and the way that the ship is making.

Having ascertained the velocity of the current, use can be made of it to find the ship's departure, and this knowledge will be most important when you fail in obtaining observations for latitude; because, in such a case, wanting a knowledge of the difference of latitude given by the current, you will be in want of everything; but if you know the velocity of the current, with it, and the course which it follows, you may find the difference of latitude and departure which the current gives; and which, though it will not give the position of the ship with that precision with which it might be obtained by latitude observed, will still approximate sufficiently to the truth to enable one to avoid danger, if prudence and seamanlike conduct are combined.

In addition to the directions previously given on pages 400—401, we add the following, for the benefit of those who have had little experience in the navigation, of sailing vessels especially, in these seas:—

1.—That it is most convenient to direct your course in mid-channel; not only because it is the farthest from danger, but because you will there have the strongest current, which is desirable.

2.—That, as you cannot ascertain, with all necessary certainty, the position of the ship, notwithstanding the rules given to diminish the errors occasioned by the currents, you ought, with the utmost care, to shun the Eastern coast of Florida, as being very dangerous, the Trade Wind blowing upon it; while there is not the least risk in running along the Salt Kay Bank, and the edge of the Great Bank of Bahama. Upon the latter, also, you meet with good anchorages, very fit to lie in during the hard Northerly gales experienced between November and March, and which do not fail to cause many damages, and sometimes even force vessels to bear away, which is always dangerous, for the weather is always thick with such winds, and the worst case will be to run into one of them upon the coast of Cuba, when hoping to have made Havana or Matanzas. Hence, therefore, as soon as there is an appearance of a North, the best way is, if near the Salt Kay Bank, to anchor on it; and, if near the Great Bank, to approach the edge of it, in order to be able to anchor when it may be necessary; for although you may have a hard *North*, so long as you can lie-to in it, you ought to pursue your navigation, as the current will certainly carry the ship through the strait.

3.—It is very necessary to sight the Kays on the Salt Kay Bank, even though you have no fear of a *North;* and there may be occasions in which every exertion should be made to make them; especially if, from want of observations, the situation of the ship is not well known.

4.—When, owing to calms or light winds, a vessel is in danger of being carried through the strait by the current, she ought immediately to approach the edge of the Salt Kay Bank, or of the Great Bank, to descend from it to the coast of Cuba, without trying to beat down the lost ground; for, by doing this, she would only render the being carried through more certain.

5.—Should you involuntarily approach the coast of Florida, you should take extraordinary care to examine whether you have advanced out of the general current and into the eddy. That you may know this, observe the eddy forms a remarkable and visible line between it and the general current, which line of division is, in many places, out of sight of land; that, in general, you have no soundings on it; and that it shows, not only by the change in the colour of the water, but that also in it, during the greatest calms, there is a kind of boiling or overflowing of the water. From this line of division the water gradually changes colour; so that, near the Florida Kays, it is of a beautiful sea-green, and at last it becomes almost as white as milk.

6.—When in the eddy you have to make the correction of currents on courses entirely different from those in the stream. This is the more necessary to be remarked, because, from ignorance of this circumstance, several have been shipwrecked.

7.—When you enter the channel, or strait, from the Tortugas Soundings, with the intention of passing through, take care to become certain of the land of Cuba, or some part of the Reef of Florida, in order to have a good point of departure; for, although the latitude and soundings on the Tortugas Bank are more than sufficient to ascertain the place of the ship, yet the variable set of the current toward Havana may produce a serious error, if not properly attended to. The meridian of Havana is, in a word, the best point of departure for ships bound to the N.E.—*A. L.*

8.—Steamers bound from the Northern ports of the United States to Havana and other ports in the West Indies, from Cape Hatteras proceed East or West of the Gulf Stream, according to the port they are bound for, making careful use of the lead in passing between it and the coast. Sailing vessels always keep outside the Stream, but make use of it on the return voyage.

On Proceeding to the Windward or Caribbee Islands.

As to choosing the North or South part of any of these isles for making your landfall, you ought to consider, *first*, which point is nearest to the port to which you are destined; and, *secondly*, the season in which you go. In the Dry Season, it is to be remembered that the winds are generally from the North-Eastward, and in the Rainy Season they are often from the South-Eastward. Thus, in the Dry Season, it is best to make the velocity of the current by the difference of latitude by account and observation. We say during the first day's work, because the generality of common navigators make use of meridian altitudes of the sun alone to find the latitude; but it is very clear that *altitudes of the planets and fixed stars ought not to be neglected; not only because by this you cannot be in doubt of your real latitude, but also, because they may be more exact than latitudes deduced from meridional altitudes of the sun, when that luminary passes in the proximity of the zenith, and because repeated observations during the night assure, as much as possible, the situation of the ship.* Thus you may go on, with a clear idea of the operation of the current, and the way that the ship is making.

Having ascertained the velocity of the current, use can be made of it to find the ship's departure, and this knowledge will be most important when you fail in obtaining observations for latitude; because, in such a case, wanting a knowledge of the difference of latitude given by the current, you will be in want of everything; but if you know the velocity of the current, with it, and the course which it follows, you may find the difference of latitude and departure which the current gives; and which, though it will not give the position of the ship with that precision with which it might be obtained by latitude observed, will still approximate sufficiently to the truth to enable one to avoid danger, if prudence and seamanlike conduct are combined.

In addition to the directions previously given on pages 400—401, we add the following, for the benefit of those who have had little experience in the navigation, of sailing vessels especially, in these seas:—

1.—That it is most convenient to direct your course in mid-channel; not only because it is the farthest from danger, but because you will there have the strongest current, which is desirable.

2.—That, as you cannot ascertain, with all necessary certainty, the position of the ship, notwithstanding the rules given to diminish the errors occasioned by the currents, you ought, with the utmost care, to shun the Eastern coast of Florida, as being very dangerous, the Trade Wind blowing upon it; while there is not the least risk in running along the Salt Kay Bank, and the edge of the Great Bank of Bahama. Upon the latter, also, you meet with good anchorages, very fit to lie in during the hard Northerly gales experienced between November and March, and which do not fail to cause many damages, and sometimes even force vessels to bear away, which is always dangerous, for the weather is always thick with such winds, and the worst case will be to run into one of them upon the coast of Cuba, when hoping to have made Havana or Matanzas. Hence, therefore, as soon as there is an appearance of a North, the best way is, if near the Salt Kay Bank, to anchor on it; and, if near the Great Bank, to approach the edge of it, in order to be able to anchor when it may be necessary; for although you may have a hard *North*, so long as you can lie-to in it, you ought to pursue your navigation, as the current will certainly carry the ship through the strait.

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5.—Should you involuntarily approach the coast of Florida, you should take extraordinary care to examine whether you have advanced out of the general current and into the eddy. That you may know this, observe the eddy forms a remarkable and visible line between it and the general current, which line of division is, in many places, out of sight of land; that, in general, you have no soundings on it; and that it shows, not only by the change in the colour of the water, but that also in it, during the greatest calms, there is a kind of boiling or overflowing of the water. From this line of division the water gradually changes colour; so that, near the Florida Kays, it is of a beautiful sea-green, and at last it becomes almost as white as milk.

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On Proceeding to the Windward or Caribbee Islands.

As to choosing the North or South part of any of these isles for making your landfall, you ought to consider, *first*, which point is nearest to the port to which you are destined; and, *secondly*, the season in which you go. In the Dry Season, it is to be remembered that the winds are generally from the North-Eastward, and in the Rainy Season they are often from the South-Eastward. Thus, in the Dry Season, it is best to make the

North side, and in the Wet Season the South, but without losing sight of the first consideration.

There can be no mistake in recognising any of the Antillas; nor, in making *St. Bartholomew* and *St. Martin* alone, can there be any doubt on seeing at once the eminences or heights of various islands. That this may not mislead any one, they must remember the following instructions:—

When in the parallel of St. Bartholomew, at less than 12 miles off, if there be no fog or haze, the Islands of St. Eustatius, Saba, St. Christopher, Nevis, and St. Martin, appear plainly.

The mountain of *St. Eustatius* forms a kind of table, with uniform declivities to the East and West; the top is level, and at the East part of this plain a peak rises, which makes it very remarkable. To the West of the mountain seems to be a great strait, in consequence of the lands near it being below the horizon, and to the West of that there then appears, as it were, another long, low island, the N.W. part of which is highest; but it is necessary not to be deceived, for all that land is part of the land of St. Eustatius. From this station Saba appears to the N.W.; it is not so high as St. Eustatius, and apparently of less extent than the Western part of St. Eustatius, which is seen insulated.

The N.W. part of St. Christopher is also seen formed by great mountains, in appearance as elevated as St. Eustatius, with low land to the East; to the Eastward of this low land *Nevis* will be seen apparently higher than all the others.

The lands of *St. Martin* are notably higher than those of St. Bartholomew; and this island appears also when you are several miles farther from it than from St. Bartholomew.

When there are any clouds which hinder St. Martin from being seen, there may be some hesitation in recognising *St. Bartholomew;* and thus it is proper to notice that the latter, seen upon its own parallel, appears small, and with four peaks, trending North and South, occupying almost its whole extent; and, if you are not more than 25 miles from it, you will see, also, the appearance of an islet to the North, and another to the South, at a very short distance. As this island has neither trees, high mountains, nor thickets, it is not subject to fogs; and it may therefore be seen oftener than St. Martin, St. Christopher, Nevis, St. Eustatius, and Saba; it is therefore advisable to keep its appearance in mind.

At 25 miles to the East of St. Bartholomew you may see *Nevis*, very high; from it to the West the strait called the Narrows, and then the lands of *St. Christopher*, appearing to rise out of the water, and which continue increasing in height to the Westward, so that the Western of the two mountains, which are at the West part of it, is the higher. This mountain, which is higher than that called *Mount Misery*, has to the West of it, a gentle declivity, terminating in low land; and it cannot be mistaken for any other. To the West of this you may also see the large strait toward *St. Eustatius;* but from this situation you will see only the high S.E. part of that island, or rather, its mountain, in consequence of which it appears like a very small island, while its mountain seem to be lower than Mount Misery; but it is easily known by the *table*, which its top forms, by the uniform declivities to the East and West, and by the peak on the S.E. part of it. *Saba* seems, from this situation, equal in size to the visible part of St. Eustatius; but it shows only an eminence without peaks, with declivities, and almost round.

If a small islet appears to the West of, and very near to St. Eustatius, that must not confuse you; for it is the N.W. extremity of that island; and, on getting nearer, you will perceive the land which connects it with the S.E. part. *Mount Misery*, on St. Christopher, which has a very high and sharp peak, on the Eastern part of its summit, seems at a distance to be the summit of Mount Eustatius; but it cannot be mistaken for such, if you attend to its surface being more unequal than the table-land at the top of St. Eustatius; and that there is another less elevated mountain to the East, and with gentle declivities, which show much land to the East and West of the high peak.

When you are 18 miles to the East of St. Bartholomew, its N.W. extremity appears insulated, and has the appearance of a pretty large island, on the top of which there are four small steps (like steps of stairs, *Escalones*), with a considerable strait to the South, between it and the principal island; in the middle of this strait you may also see a smaller islet; this is really one of the islets which surround the island; but the first is only the N.W. point, to the North of which you will see some islets: all these are much nearer St. Bartholomew than St. Martin.

Finally, in navigating from one of the Antillas to another, there is no difficulty, unless you have to get from leeward to windward; yet this will be reduced to a trifling consideration if the passage be made by the straits to the Northward of Martinique, in which the currents are weakest; but the same does not follow in the Southerly straits, in which the waters set with more vivacity toward the West: and it would be impracticable by the Straits of Tobago, Grenada, and St. Vincent, in which the waters commonly run at the rate of not less than 2 miles an hour.

Particular Instructions for the Navigation of the Windward Islands, etc.

It has been remarked, by an experienced captain in the Royal Navy, that for *sailing vessels bound to Jamaica or any of the ports in the Northern range of islands* (the Bahamas excepted), the safest land to make is the Island of Desirade, near Guadaloupe; for, if you should not see other land before dark, you may haul to the Northward, into the latitude of Montserrat, having nearly 60 miles to run on, during the night. Some commanders make St. Martin or St. Bartholomew, when bound to Tortola, St. Thomas, St. Croix, and the islands to leeward; but in this case they should be aware of the dangerous Island of Barbuda, and also of Anguilla; for a small error in the latitude, perhaps, from want of an observation, or irregularity in the current, would place them in a very perilous situation, should they attempt to run on in the night.

Strangers should pass St. Martin, when they make it, on the North side, the passage between it and Anguilla being clear; St. Bartholomew, Nevis, St. Christopher, and Antigua, on the South side. Barbadoes should likewise be passed on the South side, in order to fetch into Carlisle Bay; and Grenada and St. Vincent on the South side. No particular directions are necessary for the other islands, as every seaman knows the danger of running to leeward or past the land;—a very serious occurrence for a dull sailing vessel.

Vessels on making Barbadoes and the other Windward Islands, when approaching from the Northward, should be very careful not to cross the latitude of the low or Northern islands during the night, although their reckoning may be many degrees to the Eastward of the isles. The low islands, on which so many vessels have been lost, are *Barbuda, Anguilla, Dog and Prickly Pear, Sombrero, Anegada*, and its *Horseshoe Reef;* of all these, the first and last are the most dangerous. Before you see Anegada, in clear weather, Virgin-Gorda, and perhaps Tortola, will be seen very distinctly; distance is often deceiving at sea, and this land, by those not well acquainted with it, has been frequently mistaken for the East end of Porto Rico; and, although directions have been given for avoiding this error, by observing that there is only open sea to the Eastward of Virgin-Gorda, and that to the Eastward of Porto Rico lie several islands, yet it is necessary to observe that these islands, when the high land of Porto Rico is first discovered, cannot be seen, so that, if you make the land at the close of the day, it is well to be aware of this circumstance. It may also be remarked, that Anguilla and the Dog and Prickly Pear Isles cannot be seen until some time after you make St. Martin, which is high land, and lying to the Southward of these low isles. Barbuda is dangerous in the night time only, but to strangers also, in the day, having reefs under water all round, excepting at the extreme S.W. point.

On passing to leeward of the high islands which obstruct the course of the Trade Wind, danger arises from strong gusts coming from the mountains, which sometimes dismast a vessel. Be cautious to keep so far from such land as to be able to work your ship, should the wind suddenly shift and blow on shore, which it often does during the day. When the wind is baffling, you will find it advantageous to keep your course along shore so long as you have steerage-way, although all your sails may be aback; for it frequently happens that the wind comes round to its former quarter before you lose your headway, and by this one ship may get into another current of air, which brings her into a fresh breeze, while another, in company, by altering her course to get her sails full, loses the opportunity of getting into the breeze, and may be detained by calms and baffling winds great part of the day. We have often seen the after-sails filled, with the wind aft, while the headsails were flat aback, with the wind ahead, which continued so long that the foresail was hauled up to continue the headway.

In navigating among the Windward Islands, every precaution must be taken in allowing for the direction and strength of the currents. It has already been shown, in the preceding section, that the general prevalence of them is to the Westward, but with different velocities, disturbed at times by the lunar influence, and varied by the contour of the coast, &c. An Easterly current is seldom or never found out of sight of land, but

N.W. and Northerly, in the passages, may generally be found; and it has been remarked that, in some instances, when the current runs to leeward on one side, it runs to windward on the other; also, that it may set to windward on both sides, while at the same time, to leeward in the middle, and frequently the reverse.

The intelligent officer to whose book we are indebted for these observations, says, "In the daytime, attention to the progress you may make in getting to windward, by the appearance or bearings of the land, is the best rule you can have, first trying a short tack inshore, where, if you make little or no progress to windward, your best way is to stand across, and try the other side of the channel; and, if that do not answer, the mid-channel will most likely prove the best; for, although contrary to the general opinion, we have often found it so; much, however, depends on the time of day. In the morning and evening you should endeavour to be near the shore, the North side of the passage in preference, where if the wind be moderate, and the coast not much exposed to the general Trade Wind, you are pretty certain of having the wind two or three points off the land. In like manner, you should endeavour to be in the offing about one o'clock, p.m., as the wind generally blows more on the shore at that time. We have also observed that the land and sea breezes prevail most where the land on the coast is low.

"*Should you be bound to a place to the Eastward of you*, and no land in the way, the best tack to be upon is the one on which you will lie up nearest to E. by N., that being the point from which the Trade Wind generally blows; when it changes from that point you may consider it a slant of wind, and take advantage of it accordingly—particularly if it veer to the South during the day, or to the North by night; thus it will be found to be advantageous to be on the port tack at night, and the starboard tack by day."

In squally weather the wind is so very variable, that it is seldom possible to take advantage of it in getting to windward.

To windward of the islands and to the Northward of Barbados, in moderate Trade Winds, the Equatorial Current will be found generally to set from N.W. by N. to N. by W., at the rate of from half to three-quarters of a mile an hour. As you approach the islands, it becomes more irregular; near to the Eastward of *Point Salines*, Martinique, it frequently sets strong to North, and even N.E. We have have also felt this set of the current near to Point Moulacique, the South point of St. Lucia, and have frequently seen vessels bound to Gros Islet Bay, St. Lucia, from Barbados only the night before, driven so far to the North as to have passed the Island of St. Lucia, and also a considerable part of Martinique, before they discovered their mistake; and, being strangers, they had to wait until an observation could be taken to ascertain the latitude, before they could find out their true situation.

In the passages lying nearly in a North and South direction, the current sets generally about N.N.W., until you are past the most northerly land on the Eastern side of the passage, when the Western current, being no longer obstructed by the land, sets with great strength in a more Westerly direction. This is the case in all the passages from Antigua to Hayti, and those on the South between Trinidad and Paria, and on the coast and Leeward Islands from Margarita to Buen-Ayre, as the current inside to the South of these islands (in the dry season) sets about N.W. by N. ½ N., at the rate of nearly 2 miles an hour. Ships running to Westward, inside, should make an allowance for it, and keep a good look-out, for it must be borne in mind, as already shown, that the currents here are variable, according to the season.

In order to touch at as many of the Windward Islands as possible, without having to beat to windward; suppose your vessel to be at Barbados, and you have to call at as many islands as you can, in as little time as possible—from Barbados you can steer for Tobago, hence for St. Vincent, which is as far to windward as you can fetch; and, with a Northerly Trade Wind, you will not be able to do that. From St. Vincent you may steer to any of the Grenadines, and so on to Grenada; and at times you may fetch Trinidad, but this is not to be depended on. From Grenada you cannot always fetch St. Kitts, but in general, the Virgin Islands, St. Croix, St. Thomas, &c. The general course this way is to go to Tobago, and thence to Trinidad.

Another track is from Barbados (S.W. side) to St. Vincent (South side), hence to the Grenadines and Grenada.

From Barbados to the N.W. you may go to St. Lucia, passing round the N.E. point of the island to Gros Islet Bay and the Careenage; from this place you fetch Fort Royal Bay, Martinique, then St. Pierre, Roseau (Dominica), the Saintes, Basse-terre, and sometimes Point-à-Pitre, Guadaloupe.

From Basse-terre, Guadaloupe, you can seldom weather Montserrat, unless you tack and take advantage of the variable winds under Guadaloupe, which is the best way, if you are bound to Antigua, or to the Northward between Antigua and Nevis; but if not, you may pass close to the West side of Montserrat, and so steer for Nevis or St. Kitts, or to the islands to the Westward; or you may pass on either side of St. Eustatius or Saba, if you can lie round without tacking, and so through the Dog and Prickly Pear or Sombero Passage to the Northward.

In steering through these passages, or across them, it is recommended to keep well to windward, as the wind will often head you as you approach the opposite side, and the currents are very strong; and it may be remarked that, in standing to the Southward, you feel the force of the current more than when you are standing to the Northward.

From these remarks, and a reference to the chart of the islands, it may be readily seen what other track can be accomplished. Thus, from Barbados to Antigua, and the islands to the Westward of it, you pass to the Eastward of Desirade if you can; if not, between that island and the East point of Guadaloupe; when you are clear of this last point, you have Antigua and all the islands to the Westward in your route.

The intercourse by sailing vessel between Barbados and Demerara is very uncertain, and you cannot always trust to fetch from one place to the other, even in fast-sailing vessels. From Demerara you can generally weather Tobago; of course, it must always depend on the wind and current; therefore we speak in general terms only. Indeed, we have sometimes seen Southerly Trade Winds continue for a long time, and also Northerly winds; and we have seen, owing to N.E. winds and lee currents, vessels from Cayenne not able to weather Barbados, and a vessel from Antigua a month in getting to Barbados, owing to Southerly winds.

In working to windward through any of the passages in the night time, it is strongly recommended not to trust to the distance run; for, although you may have an offing of 12 miles, and you could lie up so as to make a long stretch, yet, before you have gone the distance of your offing, you will probably find it full time to tack from the shore. *In the passages lying nearly East and West*, the Westerly current runs so swiftly, that, in standing to the Southward on the port tack, and lying up S.E. by E., you will often find that you have made little or no Easting. This has been the case with several vessels leaving the South shore of Antigua; they stood on, lying up S.E. by E., which course they expected to make good, and thought perhaps to weather Point Antigua on Guadaloupe, but the current deceived them, little or no Easting had been made, and they ran ashore among the small kays of the Bay Mahaut, Guadaloupe, nearly due South from that part of Antigua which they had left the previous evening.

When bound to windward it is sometimes difficult to beat through the passages between the islands. Of these passages, the easiest are considered to be between St. Vincent and Becquia, between Martinique and St. Lucia, and between Antigua and Guadaloupe. The wind, in general, blows a strong breeze, so that a vessel may carry double-reefed topsails, courses, top-gallant sails, jib, and driver. These are the most suitable sails for working the ship during the night, the weather in the passages being too generally squally. If more reefs are out, you will be liable to spring your masts and yards; for, however fine the weather may appear, strong and sudden gusts may come on several times in an hour. Finally, too much sail is hazardous, as the squalls may head you until they blow past, when you come up to your old point; and in this way it is obvious you may run a long way to leeward in carrying sail through a squall.

GENERAL REMARKS ON THE NAVIGATION OF THE CARIBBEAN SEA, FROM LEEWARD TO WINDWARD, BY LIEUT. GREEVELINK.

The best way to beat up in the Caribbean Sea is still an object of dispute among a great many European mariners; there are some, and they form the greatest number, who always prefer the Northern part; others who choose to keep in the middle between 14° and 16° of latitude; and a few, to beat up off the Southern coast, till they are able to make Antigua, and run out by the channel between that island and Guadaloupe.

The first of these methods, the one generally adopted, is evidently the best; as the South coasts of Hayti and Porto-Rico are tolerably clean, and afford smooth water when the wind is to the Northward of East; but in the Hurricane months, this part is rendered unfavourable, not only by these dangerous visitors, but also because the currents are then often very strong in the Northern channels, whereas they have, at the same time, been observed to be very weak in those Southward.

The second route depends, I imagine, more on vague reports of a current setting between those parallels to the Eastward; but this will, I trust, no longer be credited, at least, in the tract of sea here described. During the intervals, however, in which light winds are of some duration, the Westerly current may be found very weak, as is undoubtedly proved by our passage in April, 1837. Yet this is no reason why a constant weak current, or an Easterly one, should be stated to exist, when found only occasionally in those parts where they have once been met with.

The third route, by which the Hurricanes are generally avoided, has been treated with too much neglect, partly by its being impeded by the Leeward Islands, and partly by the unknown force and direction of currents, and want of local experience of the coast; but hereafter I doubt not but this track will be adopted as the best in those months which threaten destruction in the Northern passages, because it is almost universally followed by the coasters and pilots.

Commanders bound from one of the interior ports of the Caribbean Sea, toward the coast of Guayana, generally prefer passing out by the channel of Antigua and Guadaloupe, which is one of the fittest for that purpose with Northerly winds; but when, on the contrary, the wind is from the Southward of East, I should not advise any attempt to pass that way, but to proceed directly to the North, by the Westward of Barbuda, prolonging the stretch well, in order to gain, with the other tack, the windward side of the islands. In July, 1836, we laboured for several days to get out of the first-mentioned passage; and in August, 1835, we were happy enough to reach English Harbour, though unable to effect our purpose of getting into the main sea, being harassed by South-Easterly winds and strong Westerly currents.

After having reached the Atlantic, when bound toward the coast of Guayana, it is best to keep your wind, if blowing from the Northward of East; as, in that case, it may enable you in one stretch to make the desired port; but, with unfavourable winds, I think it advisable to run straight for the coast, and beat to windward along the bank of soundings. This is most probably attended with less loss of time than the working to the Eastward in higher latitude, which may be proved beyond any doubt by comparing some of the many instances which have occurred of vessels falling to leeward of their port of destination, and trying to regain it by making a long stretch to the Northward; when, after fourteen days, they made the coast nearly at the same place; with those of others who effected it completely in only three or four days, in the space mentioned. I know many reports of this sort, but they want sufficient authenticity to be relied on.

As a general remark, it may be kept in mind that to get soundings ought to be the principal object of ships bound to this coast, as, with the present knowledge of depths hereabout, together with an observed latitude, it may show them their place of situation East or West of the intended place very near the truth, because the general tendency of the mud-bank is nearly N.W. and S.E.; and thus, to the Eastward of a certain meridian, there will be found more water than to the Westward, upon the same parallel.

It is absolutely erroneous to state that the limit of soundings is marked by the change in the colour of the water; as more than once, and particularly in November, 1834, in 25 fathoms of water, to the N.E. of Marowyne River, the colour was perfectly blue and transparent, and at other times tinged of an ashy hue by the mud.

Some remarks on making the coast about Colon are given previously, on pages 364—365.

STEAM NAVIGATION BETWEEN TOBAGO AND DEMERARA.

This and the following two sections are chiefly taken from an illustrated work,* which gives numerous directions for the West Indies :—

Between *Tobago* and *Trinidad* the current sets along towards the W.N.W. and W.S.W., nearly always at the rate of 2 knots per hour, and not unfrequently 3 or 4 knots.

After clearing the channel, the stream will generally be found running nearly parallel with the line of coast the whole distance to Demerara, though it sometimes takes a more Northerly direction, particularly in the months of July, August, and September.

In shaping a course, therefore, for *Demerara*, vessels should keep well to the Eastward of the port, not only to avoid the banks off the mouth of the *Essequibo*, but because the objects to the Eastward are more remarkable, which is of the utmost consequence on a coast where its features bear one uniform appearance, without a hill, the bearing of which would point out a ship's position; and the land so low that vessels may be aground before it is visible. The *lead* will be found the best guide, as the soundings very gradually decrease, and there is no danger while navigating in 7 fathoms water.

The most remarkable features of the coast are the chimneys of the boiling-houses, and a uniform fringe of trees. The vicinity of Demerara will be known by the openings among the trees, with occasional buildings and chimneys. Then the lighthouse and a high church spire will render its position easily recognisable. This port should never be taken by a stranger without a pilot; indeed, even those who are most intimately acquainted with its localities should always take this precaution. In a steam-vessel the navigation is most simple at proper times of the tide. Every merchant vessel is compelled to take a pilot before crossing the bar.

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* "Practical Observations on the West India Navigation," by a Commander of one of the Royal Mail Steam Packets. London, 1844.

NAVIGATION TO JAMAICA *via* ST. JUAN, PORTO RICO, CAPE HAYTIEN, AND ST. JAGO DE CUBA.

Steamers leaving *St. Thomas* to perform the *Jamaica* route, *via* the North side of *Porto Rico* and *Hayti*, should leave the small islet of *Bergantin* (which is a high rock resembling a ship when at a distance), on their left, and *Montalvan* and *Cabrito* on their right, bearing in mind that a *reef* extends from Montalvan a good cable's length.

San Juan Harbour will readily be distinguished by the *Moro*, which, when first seen, makes like an island having extensive fortifications on its summit, rendering it exceedingly remarkable. This *Moro Castle* is on the East side of the entrance, and is steep-to within half a cable of its Northern side. The position to lie-to for a pilot is about 2 cables North of the Moro, with the ship's head off shore, taking great care not to drift near the low rocky island on the West side of the entrance, which has much foul ground around it; and the current generally setting strong in that direction. The harbour is not difficult of access by day, but at times the sea breaks right across the entrance, which calls for the promptest attention at the helm. I do not consider it safe at any time to enter this port at night in large ships. Rise and fall of tide, 2 feet.

From *San Juan* a course should be shaped so as to pass 6 or 7 miles from *Cape Viejo Français* (Hayti), making allowance for a current which sets towards the Porto Rico coast, when within the distance of 10 miles from the shore. The first land that will be seen on this track (after losing sight of Porto Rico) will be *Cape Raphael*, which is of moderate height, and is the termination of the high land; the coast thence to *Cape Engano* being exceedingly low. *Raphael* may also be known by a small conical hill (*Mt. Redonda*), a short distance inland, which, on coming from the N.W., is seen near the termination of the point.

The next cape to the N.W. is *Cape Samana*, which makes like an island on many bearings, particularly from the N.W. After passing Cape Samana, *Cape Viejo Français* will be seen, which also makes like an island with low points at each extremity.

Cape Isabella is the next headland, which is very low, and, like Cape Viejo Français, also makes like an island. Between these two capes there is a remarkable high hill, sloping down to the water's edge, with a flat summit, and a remarkable notch on its extremity when seen from the N.W. This land is *Cape Casrouge*.

The *Grange* is the most remarkable object, and cannot be mistaken for any other part of the coast if attention be paid to the book of directions.

Vessels may pass inside Monte Christi Shoals; but as the channel is not well known, I have invariably gone outside, on the principle that a steamer's progress is so rapid through the water, that in a very short period of time after shoal water is descried, the vessel is on shore. Although I have adopted this line of route, I have, on former occasions in H.M. ships, passed inside, and am well aware that there is a good channel; but a large scale chart of this portion of the coast should be in possession of the commander before he navigates his ship in doubtful water.

Cape Haytien is a high cape, sloping down towards the East, and having a small rock, called *Picolet*, at its foot, presenting the appearance of a white patch when first seen from the Eastward. The water is deep tolerably close to this rock, and it may be approached to the Northward without fear. I should, however, recommend all vessels to go in at slow speed, with strict attention to the *lead*.

From Cape Haytien the course should be shaped to pass between the *Tortugas* and *Hayti*, in which channel there is always much less sea than outside, besides being a more direct course.

St. Jago de Cuba.—This harbour cannot be taken at night, and never even during the day without a pilot, as it is exceedingly narrow, and the greatest attention is required at the helm, owing to the sudden turnings in the channel.

From St. Jago de Cuba to Morant Point, I would recommend a course to be shaped (during night time) 15 miles to the West of the *Formigas*, as I have on more than one occasion experienced a set in their vicinity of half a mile an hour to the N.E. This is by no means a usual occurrence, but knowing the existence of deviations from the general set of the stream, it is as well to be on the guarded side, more especially as the saving in the distance is very trifling.

Morant Point is very low, with a *lighthouse* upon its extremity; from hence to the *Keys of Port Royal* it is only necessary to run down about 2 miles off shore, taking great care at night to avoid the low land about *Cowbay Point*, which is very deceiving.

On returning by this route, the foregoing observations will be equally available. It is, however, perhaps as well to observe, that after leaving St. Jago de Cuba great advantage may be gained by keeping about 2 miles off shore, where there is frequently a weatherly set, and invariably less current.

In making *Porto Rico* from the Westward the land is low, gradually rising to a high chain of hills; thence, trending East, it again falls, and then rises to another chain of mountains called *Luquillos*, which terminate in low land at the Eastern extremty of the island. *St. Juan* may be known by its situation between the above two ranges of mountains, and by having on its West side a number of remarkable hillocks in the form of *haycocks*, which are frequently seen before the *Moro* shows itself; but the fortifications are most commonly the first objects descried.

I would also caution vessels to be extremely guarded at night, in not mistaking the channel between Culebra and Porto Rico, which is exceedingly dangerous. The distance run by the ship after leaving St. Juan will of course be a good guide, but between August and October the currents are often so variable, that the most careful navigator may be deceived in hazy weather, or at night, as there is under these circumstances a great resemblance between Culebra and St. Thomas. The latter, however, if seen before sunset, may be distinguished by its being higher, and making in three small peaks.

From the mean of several observations, I have found the current along the Porto Rico coast and Hayti to the Northward to be as follows, though the very unusual state of the weather in the West Indies of late has rendered these very uncertain, and therefore great care should be taken in ascertaining the direction of the stream, always distrusting published accounts.

Between latitude 18° 29′ N. and Porto Rico, the current generally sets obliquely on the shore towards the E.S.E. Between 18° 29′ and 18° 39′ N. it runs to the E.N.E. To the Northward of this latitude the stream takes a more Northerly direction, particularly in the vicinity of the *banks* of the *Bahamas.*

To the distance of 10 miles along the *North Coast of Hayti,* the current frequently runs towards the shore, but beyond that distance it takes the direction of the coast.

During the Hurricane months it should be remembered, that the currents are more uncertain than at any other period.

Navigation between Grenada and Jamaica, along the South side of Hayti to Jacmel.

Leaving the island of *Grenada,* the current will almost invariably be found setting between W.S.W. and W.N.W., but more commonly in the former direction than the latter. It is generally strongest between December and April, and of least force in the Hurricane months ; indeed, between July and October (on reference to former journals), I find not unfrequent sets to the East and N.E., particularly when Hurricanes have visited any part of the West Indies ; but except in these months it is very rare to find the stream deviating from the W.S.W., West, or W.N.W.

The little island *Alta Vela* lies 6¼ miles S.W. ½ W. from the S.W. end of *Beata Island,* in lat. 17° 29′ 30″ N., long. 71° 38′ W., and is directly in the fairway of steamers coming from *Grenada* to *Jacmel.* It is 500 ft. high, barren, and at three-quarters of a mile North of it is a low black rock.

The course from Alta Vela to *Cape Jacmel* is about N.W. ⅜ W., 68 miles ; on which line vessels will make the *Frayles,* which lie about 10 miles Westward of *Beata Island.* They are a cluster of steep reddish-coloured rocks, and are said to be steep close-to, though I would advise ships to give them a berth of a mile at least ; also, I would not take the channel between *Alta Vela* and *Beata Island,* as scarcely anything is to be gained by it.

The current most commonly sets very strong to the Westward in the vicinity of the islands ; but after passing *Frayles Rocks* a strong S.E. set is frequently experienced, particularly during the night, when the Trade does not blow home.

From *Jacmel* to *Jamaica,* shape a course so as to pass 5 miles clear of the *Isle of Vache,* which is about 8 or 9 miles in length, and makes like a group of small islands when first seen, particularly from the Westward. The current between this island, and along shore to *Jacmel,* generally sets to the Westward, but when within 5 or 6 miles of the shore, an *Easterly* set is frequently experienced, particularly at night.

The first headland after passing the *Isle of Vache* is called *Abacou Point*, low at its extremity, then suddenly rising to a moderate height.

The next cape to the Westward is *Cape Gravois*, which is very low, the land between being of a moderate and equal height. From this cape to *Tiburon* the land becomes very high. Cape Tiburon itself is of moderate height, but a short distance from its extremity it suddenly rises to a high mountain, and when first made from the sea, appears to slope down to the water's edge.

The *Isle of Saona* is situated at the S.E. extremity of *Hayti*, and is very low, level, and covered with trees. In running past this island, shoal water will be seen some distance from the shore. At night I would recommend running 10 or 12 miles to the Eastward of the reckoning, when bound through the *Mona Passage*, as it is the *turning point*, and being very low, ships would be in the reefs before seeing the land, except with clear nights.

FROM JAMAICA TO THE BAR OF MARACAYBO, IN APRIL AND MAY, BY CAPTAIN DUNSTERVILLE, R.N.

On sailing from Jamaica we had fresh Easterly winds and squally weather, then winds variable round the compass.

From *Alta Vela* we took our departure for the Isle of *Oruba*, on the Eastern side of the Gulf of Maracaybo, allowing for the strong Westerly currents above three-quarters of a mile an hour.

Saw the *Monks*, which are rather high rocks; and, by the altitude of the star *Antares*, made the Northern one to lie in lat. 12° 28′. Hauled to the S.E., and ran along the Western coast of Paraguana, sounding in 12 to 8 fathoms, when distant about 3 miles from the shore, till we arrived at *Punta de los Estanques*, whence we took our departure for the Bar of Maracaybo, S.W. ½ W.

About 24 miles to the Eastward of the *Bar of Maracaybo*, are some high mountains; the land Westward of these is low, and continues so, with occasional breaks in it, by kays and hillocks, which are at the entrance of the lagoon. Farther Westward are two pieces of land, not particularly high, on the low S.E. termination of which are three little hillocks. This is the *Isla Todos*, on which stands the Castle of St. Carlos. When bearing S.S.W. ¾ W. the hillocks are over the fort, which is white. The bar has at this season a depth over it of only 11 ft., hard bottom; but in the rainy season, August, September, and October, there is, at least, 13 ft. of water.

The breezes here are very heavy from the N.N.E. to N.E. by E. in the early part of the year; yet at about 8 a.m. the wind is generally more moderate; and from 2 p.m. to 2 a.m., in the following morning, it blows a perfect gale, with a heavy sea, which makes it dangerous to lie at anchor here.

The best anchorage off the bar is in about 5 fathoms, with the Castle of Bajo Seco South or S. by W.; about 3 or 4 miles off shore. The soundings on the South side of the bay are regular, decreasing gradually towards the shore. The current runs to the N.E. when the moon rises; and it is high water, on full and change, at $5^h 15^m$.

In beating to windward, endeavour to be near the North-Western shore at about 1 p.m., in order to take advantage of the winds which draw to the N.N.E., so as to make a good lay to the Eastward.

The communication to the city of Maracaybo is kept up by one of the ship's boats, hiring a pilot for the occasion, who, on making the usual signal, will come out from Bajo Seco in a boat with latine sails, should the weather be moderate. If you have to communicate frequently with the city, or to cruise in the gulf, I should recommend beating up to the anchorage of Estanques, in the Peninsula of Paraguana; but, in beating up, do not go to the Eastward of Punta Gorda, the S.W. point of Paraguana.

The *Anchorage at Estanques* is very good for a vessel of the largest class, even within half a cable's length of the beach. The best marks for assisting a stranger to find the anchorage is the Mountain (or Pan) of *Santa Anna*, which much resembles Vesuvius, and may be seen, in clear weather, 24 to 27 miles off. This mountain, when bearing E. ½ N., leads to the anchorage. The place may also be known by being a long tongue of sand, with some huts on the extreme point, occupied by fishermen, who in the season take immense quantities of fish by the seine. The *Bustard* lay in 4½ fathoms, and veered to 25 fathoms on the N.E. anchor (from which quarter the prevailing winds come strongly), and 82 fathoms on the best bower to the S.W.; Point Estanques bearing S. ½ E., and Point Salines, N.W. by N. ½ N., 2 cables' lengths off shore. No supplies can be obtained here. Rabbits may be shot, but can be purchased cheaply. The little water that may be procured is muddy, and not fit to drink.

If you are bound to the Eastward, when clear of the gulf stretch to the Northward, as the currents run so strong between the Isle of Oruba and Cape St. Roman, that it is nearly impossible to beat through; but should you go between the island and main, be cautious in standing by night to the S.E., as the coast from Cape Roman to Aricula, 19 miles to the S.E., is very dangerous, and the currents set thereon.

In stretching across, from *Point Chicabacoa*, on the West side of the mouth of the gulf, to Jamaica, we found a strong current, running due West, nearly 1 mile an hour.

THE CHANNELS OF PROVIDENCE.

The *Channels of Providence*, between the Great and Little Banks of Bahama, are copiously described in the Sailing Directions accompanying the chart, as well as the winds and seasons of this portion of the West Indies. The lighthouses on Gun Kay and the Great Isaacs in Florida Strait, together with those erected on the Florida Reefs by the United States Government, and the fine line of beacons along the face of the latter will be eminently useful in facilitating the navigation. We have been assured, by an intelligent navigator, that it was not unusual for twenty sail of vessels, from 100 to 400 tons burthen, to pass Great Stirrup Kay within musket-shot, and even within hail, in one day; these, for the most part, proceeding from the United States to Cuba and the Mexican Sea. They made the Hole in the Wall, now distinguished by its lighthouse, then the Stirrup; thence, if the weather appeared threatening, they passed through the N.W. Channel; otherwise they shaped a course, picking their way, across the Great Bahama Bank, to the Southward of the Cat Kays, beyond Gun Kay lighthouse. Here they entered Florida Strait, and pursued a Southerly course, where the Gulf Stream is found, as described, to run with the least velocity to the Northward.—(See farther, "Sailing Directions accompanying the Chart of the Windward and Gulf Passages," published by Mr. Laurie).

Directions for Proceeding to Demerara, etc., from the N.E.

The following remarks, made by Captain George Cheveley, will be found useful:—

"If, when in lat. 10° N., the water changes to a dark or black colour, or dirty drab, and then in 8° turns again to the usual sea blue, you may rely on being to windward. There are no soundings, only this remarkable change. You will then, in running farther in, on the coast, observe a perfect division, or line of change, on the water, nearly N.W., from blue to green, where the current sets strong in that direction. On proceeding, you will again change to thick muddy water, influenced by the Tides, which should be carefully calculated and allowed for. Many ships have run to leeward from want of this, and a due allowance in the course when the tide is running, which is always with the flood. As you approach inshore 4, 5, and 6 fathoms, should the water then be of a *red* colour; you may make sure of being to windward, and need not fear running, even should you obtain no pilot. This is most perceptible from Miconie down to Corobana Point: to leeward all is dirty, thick mud.

"With the lighthouse on the weather point of Demerara River bearing from South to S. ¼ W., flood making, you cannot do wrong by steering in on that course, should you not obtain a pilot, and come-to off the fort, keeping outside the poles on the West side. I mean this is a safe plan for a stranger."

The following is by Captain Henry Faithfull, June, 1865:—

"In making the land to the Eastward of Demerara River, the coast is very low, and scarcely above the high-water level—the sea at that time rising into the jungle, when the tops of the trees alone are visible at the distance of 10 miles off the shore; the sameness of the whole coast is such that it is impossible to say where you are by the look of the trees,

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[*] **This discoloured water appears to be in the stream of the *Equatorial Current*; as may likewise be that which is met with at 250 or 300 miles to the East of Barbadoes.—Ed.**

consequently the lead is the only sure guide by night or day. Soundings may be obtained 150 miles East of the lightvessel, in 35 fathoms, much sand, little mud, and small stones; the nature of the ground changes as you advance to the Westward—less sand, more mud, and no stones,—until in 12 fathoms it is all mud. During the night or early in the evening, it would be advisable to make Berbice lightvessel, which, under ordinary circumstances, cannot be mistaken for the Demerara lightvessel. It is well in sight from the deck when in 13 fathoms, mud, and is about 50 miles from Demerara lightvessel, to which the course is about N.W. by W. by compass, but allowance must be made for tide—flood setting S.W., ebb N.E.,—the average strength of the flood being 2 miles, of the ebb 3 miles,—the ebb increasing in the rainy season to 5 miles and the flood decreasing to 1¼ mile per hour.

" By constantly keeping the lead going, and subtracting one-fourth of a fathom from the soundings, for the lead sinking into the mud, you will not get into danger, but on no account should a vessel be brought into less than 6½ fathoms by night or day; there is no danger of missing the lightvessel in this depth; she is anchored in about 19 feet at low water, and springs rise 9 feet. At night time, in coming from the Eastward, the *revolving* light on the point, visible 16 miles, will first be seen; if not bearing to the Southward of West, haul out immediately—the tail of Litchfield or Lusignan Bank, with 8 feet at low water, is between the ship and the light, and your ship is in danger of sticking in the mud; when the lightvessel is seen bearing West, steer for her, and round-to, to Westward, as close as possible; a pilot will be sent immediately, day or night.

" The three great things in coming up this coast are *Lead, Lead, Lead.* In case of getting ashore on this coast, there is no fear of the vessel going to pieces—the bottom is too soft; but there is no landing on the coast, for it is too muddy. The boat that leaves the ship to get assistance must find a creek or trench, and go up it at high water; she is sure to find a plantation a few miles inland, and can then send to George Town for assistance. Once on shore and requiring steam, the commander may think himself very lucky if he gets off under £1,500.

" In the rainy season the wind is frequently from the Westward. In beating up do not come into less than 7 fathoms—under that the rollers have too much power over a ship in light winds; should a vessel get under that depth in a calm, or from the wind having suddenly failed, with flood tide, anchor immediately with 60 fathoms of chain—getting under weigh again when tide is done. These directions refer to ships of 1,000 tons, and not to coasters. If, coming from the Northward, in 8° N. you have 30 or 32 fathoms, the lightvessel bears due South of you; if more, you are to the Eastward; if less, to the Westward.

9.—PASSAGES TO AND FROM THE NORTHERN PORTS OF AMERICA.

In the introductory remarks to this section of the work, we have alluded to the principles of Great Circle Sailing, and have pointed out the advantages which it possesses, not so much in the shorter distance which it gives over the rhumb course, but in the scope it allows the navigator in the choice of a parallel on which he can make a good passage, without materially increasing the actual distance to be sailed over.

" In no case can this be better exemplified than in the course over the Northern parts of the Atlantic, between the British Isles and the Northern American ports. We alluded (page 460) to a case, not impracticable, of the courses between the Land's End and Cape St. John, in Newfoundland, and showed that two courses might be taken not more than 35 miles greater than the *shortest* distance, of exactly the same length, and yet be 330 miles apart in latitude in their greatest separation.

An *imaginative* course will well explain this for our present purposes:—From the Lizard to Sandy Hook, New York, the distance and *true* course by Mercator's Chart are 2,952¼ miles S. 78° 51′ W. But if a vessel leaving the Lizard were to commence sailing N. 73° 24′ 40″ W., and passing about 35 miles Southward of Cape Clear, gradually bearing to the West, attaining a maximum latitude of 51° 56′ 30″, in long. 26° 27′ 20′ W., and then, if it were possible, approach New York on a S. 54° 36′ W. course, she would sail over 2,865 miles, or 87¼ miles less than the compass course. This *Great Circle course* passes over Cape Bonavista and La Hune Bay in Newfoundland; St. Anne's Bay in Breton Island; Pictou and Cape St. Mary in New Brunswick; near Boston; and over New London, and Long Island.

A line of the length of 2,952¼ miles, placed in a higher latitude than the rhumb line, as shown in page 460, is just as much *above* the Great Circle course in latitude as the latter is above that by compass. This corresponding arc from New York leads considerably inland, intersecting Chaleur Bay, Cape Bonaventura in Gaspé Bay, Anticosti, passes 45 miles N.W. of the Strait of Belle Isle, approaches within 189 miles of Cape Farewell, Greenland, attains a maximum latitude of 57° 12′ N., and intersecting the S.W. part of Ireland, at Kinsale, reaches the Lizard in a S.E. direction. These two lines, of the rhumb and the corresponding arc, are *upwards of* 700 *miles apart* at the greatest deviation from each other.

With these considerations so manifest, we shall be better prepared to understand that a higher latitude than the usually received one cannot, of itself, be disadvantageous; and by the excellent observations of Captain Hare, presently given, will be more clearly evident.

By referring to the Chart, it will be seen, that from the Land's End to St. John's, Newfoundland, the true bearing is W. 4° 30′ S.; and from the same point to Cape Sable, it is about W. 9° S. But the circumstances of navigation in general render a direct course more tedious and difficult than a circuitous route, and the best passages have been made by pursuing a *high Northerly course.*

It seems probable, from all that we have said on the Winds and Currents, that on prosecuting a North-Westerly course, from the Bank of Channel Soundings, the Winds and Currents respectively may counteract and balance each other; that, on further prosecution of the same course, the winds will be found less Westerly, and therefore more favourable than in the more Southerly parallels; and that, in advancing toward the mouth of Davis Strait, the advantages both of wind and current may be combined.

Caution must be taken not to advance too near the Eastern coast of Newfoundland, if bound to New Brunswick or the Southern ports; nor to the Eastern coast of Cape Breton Island, as here the vessel may be swept round by the strong Westerly currents, described in the preceding pages (431 to 440), and which, instead of producing mischief, may prove highly advantageous in facilitating the ship's course.

The propriety of these arguments was confirmed by experience, in more than forty passages made to and from New Brunswick, &c., by Lieutenant Charles Hare, of the Royal Navy, previous to the autumn of 1824. Annexed is a copy of that gentleman's communication.*

" Ships from Scotland, in the spring of the year, and bound to New Brunswick, have always arrived sooner than those from the English Channel; which is attributed to their being more to the Northward on leaving the land.

" Ships from Liverpool generally arrive before those which sail from the English Channel; the cause being the same.

" In the spring of the year, I would never go to the Southward of lat. 46° or 47°, until I reached long. 37° or thereabout; then edge to the Southward as far as lat. 43°, in order to avoid the Icebergs, keeping a very strict look-out; this parallel (43°) I should endeavour to preserve, or nearly so, but nothing to the Southward, until up to Cape Sable, Nova Scotia; for it carries you to a safe and proper distance from Sable Island, a place that cannot be too much dreaded. In this track you will be without the Northern edge of the Gulf Stream, and assisted by a South-Westerly current from the Banks until past that island,

" In the fall of the year my track is far more to the Northward than in the spring. On leaving the land as late as the middle of October, or thereabout, I generally steer to the North-Westward until I get as far North as 55°, and until I enter the longitude of 30°, then edge to the Southward, to enter the Banks in lat. 46°, shaping again a course to pass about 60 miles to the Southward of Sable Island, as above. If bound to Halifax, and very sure of my latitude, I might be tempted to pass to the Northward of Sable Island; but, at all events, it would be at great risk; and I should not, under any circumstances, recommend a stranger to attempt it, as the weather is mostly foggy, and the set of the currents unaccountable. Numerous gannets are always hovering about this island,

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* Many succeeding passages made by Captain Hare, since 1824, concurred to prove the propriety of those directions, which have been highly approved by American as well as by English captains. This gentleman had crossed the Atlantic for the ninety-eighth time, in the year 1839, and the *one-hundred and eleventh* in 1846.

and are a very excellent indication of your near approach to it, particularly on the South side.

"By crossing the Banks thus far North, you will find the advantage as you approach the longitudes of Newfoundland and Nova Scotia; the strong N.W. and North gales having then commenced, you will frequently be compelled to lie-to for two or three days; and should then ensure sufficient drift, before you are blown into the strong influence of the Gulf Stream; which would be the case at a few degrees to the Southward, and inevitably in a S.S.E. direction, at an inconceivable rate. Last November (1824) the case occurred; the vessel being hove-to, under maintopsail and storm-trysail, to the Westward of the Banks, in lat. 45°, was, in four days, swept into lat. 39½°, consequently into the Gulf Stream, when the longitude became also considerably affected, and I took the first opportunity of making a N.N.W. course, to get out of it as soon as possible.

"To prove the advantages of a Northern track, late in the fall of the year, I may notice that I have, in one or two instances, read in the American newspapers the accounts of very long passages experienced by ships which met heavy gales in the latitudes of 35° and 38°, when several vessels were disabled, and others suffered loss of sails; yet, *on the same day*, in lat. 54°, I had moderate weather from the N.N.E., with topgallant studding-sails set; which strongly encourages me to believe, that the blowing weather, incident to approaching winter, commences Southerly, and inclines Northerly as the season advances, and not the reverse; an hypothesis generally formed by English shipmasters, but, in my opinion, certainly erroneous.

"I am further of opinion that the influence of the Gulf Stream, in the parallels from lat. 35° to 42°, whether from the warmth of the water or other natural causes, has a strong tendency to attract the wind from a Western direction; as I have invariably found the wind more alterative in the Northern latitudes before mentioned than the Southern ones; and it unquestionably must be allowed by all mariners of any observation, that gales experienced in the Gulf Stream or its vicinity blow with much greater violence than they do in that part of the Northern Atlantic not under its influence;* besides, the squalls from the Southward or S.W. are much more sudden and heavy, and near the Banks they are attended with dangerous lightning. The thermometer is of the greatest importance for ascertaining your approach to it; and, if bound to the West, I would, for my own part, endeavour to avoid its effects as cautiously as a lee shore; for it may depended on, that no ship, however well she may sail, will effect Westing in the Gulf Stream with a wind from that quarter; and it is to be remembered that its velocity is accelerated according to the strength of those winds; and its extent in breadth, at a few degrees to the Westward of the Azores, is many more degrees than is commonly supposed.

"These observations, I hope, may be useful to my brother mariners engaged in these voyages; and permit me to say, that they are grounded on the experience of more than forty times crossing the Atlantic in the Royal and the merchant service, and in command of vessels in both; latterly in one of 400 tons burthen, the *Waterloo*, and, as the custom-books in Liverpool can testify, landed four full cargoes in thirteen following months; which, including the time required to discharge the same, then load out to St. John's, New Brunswick, there discharge and load home again, leaves but very little time for the ship to cross the Atlantic eight times in fourteen months, which, in fact, was done.

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* See the remarks upon the Gales of the Azores, in the description of those islands, later on.

"Still further, in corroboration of my approved Northern track, allow me to observe, that in the fall of 1823, by keeping a high latitude, the brig *Ward*, myself master, also owned in New Brunswick, performed a voyage out and home in seventy-two days. The same vessel, likewise, on the 3rd of October, 1824, left the English Channel, and arrived again in the Downs on the 3rd of January following.

"I must add, that a strong, well-found, and well-manned vessel, alone can perform these voyages; for they must be maintained with unremitting attention and perseverance.

"The necessity and propriety of the above remarks were particularly exemplified by the *Ward*, which, on her passing through the Downs, in 1824, left ships there that were bound to the Westward, weather-bound, and found them there on her return, having been driven back by adverse winds; while she, getting out of the Channel, performed with ease a prosperous voyage to St. John's, New Brunswick, and back, exactly in three months, assisted by chronometer, thermometer, &c."

The *New York packet ships*, when making their winter voyage from Liverpool, kept in high latitudes until nearing Newfoundland. This they did for the twofold object of avoiding the tempestuous weather so generally experienced to the Southward, and of obtaining fairer winds; and thus by slipping within the mighty stream from the Florida Channel, they evaded its retarding influence. The voyage by this route is shortened; and, although bad weather must be expected, it is not so violent as farther South; besides which the Eastern currents are avoided.

A reference to the diagrams will show the routes recommended during the winter months, as given on the United States Pilot Chart of the North Atlantic Ocean, December, 1893.

Although the voyage to and from North America, between the parallels of 60° and 40°, has always been attended with a degree of peril from masses of Ice which drift to the Southward, during the summer months, from the Polar regions, yet many an unwary mariner makes his run across the Atlantic without any apprehension of meeting these floating dangers, or without sufficiently exercising a proper discretion and vigilance to guard against coming in collision with them. Commanders of ships should, therefore, bear in mind the imperative necessity there is for using their utmost vigilance and attention when crossing the above-named parallels, especially between the meridians of 30° and 60° W., to guard against coming in contact with these formidable dangers of the ocean. Upon the subject of the Ice which comes down from the Northern latitudes, much that is interesting and very necessary to be known will be found in pages 441 to 454.

On pages 511 to 520 we have already given directions for vessels taking the *Southern Route* to the West Indies and the ports of North America, and this is especially used by sailing vessels, or small powered steamers. If bound from the British Isles to Halifax, for example, after making the necessary Westing to insure not being set into the Bay of Biscay, shape a course for Madeira, which may be passed on either side, except during November, December, and January, when it is preferable to pass to the Westward, on account of the prevailing strong Westerly gales producing eddy winds and heavy squalls on the East side of the island.

After passing Madeira steer to the South-Westward until within the Northern limit of the N.E. Trade, when alter course gradually to the Westward. Cross the meridian of 40° W. in lat. 26° N., continuing on this parallel to 48° W., when pursue a more North-Easterly course, passing about 200 miles Eastward of Bermuda, and thence laying the course for Halifax. In crossing the Gulf Stream, between 38° and 42° N., the current will be found to set about E.N.E., 20 to 70 miles a day.

A reference to the diagrams, facing page 459, will clearly show what route it is advisable to follow, according to the month or season in which the voyage is made.

Gulf of St. Lawrence, &c.—Those bound to the Gulf of St. Lawrence, after passing to the Southward of the Virgin Rocks, on the Grand Bank, and the Island of St. Pierre, should keep a middle course between Newfoundland and Cape Breton Island; not forgetting what has been heretofore said on the winds and currents. Recollecting also, that the harbours on the coast, Westward of Fortune Bay, are impeded with dangers; there are many rocks about the entrances, and many of the harbours are imperfectly known. The rocks are not to be seen in thick weather, and fogs prevail very much on the coast.

Commanders of vessels bound to the Gulf of St. Lawrence will do well to observe that, off the South coast of Newfoundland, between the meridians 55° and 56°, and the parallels of 45° and 46° 15′, is a deep gully in the sea, extending about 90 miles in a true North and South direction, and separating the Bank of St. Pierre from the Green Bank, its centre being in lat. 45° 50′, long. 55° 15′. *The method adopted by the French vessels bound to St. Pierre, for making that island, is as follows :—*

From the longitnde of 52° W., in lat. 45°, they steer a N.W. course by compass, which carries them across the Green Bank, in 48 fathoms of water; and when on the meridian of 55° 10′, in about 45° 35′ N., they suddenly deepen their water, from 45 to 90 fathoms. A further run on the same course of about 10 miles carries them across this gully, when they shoalen their water again to 35 and 30 fathoms; and, after a further run of 23 miles, they steer about N.N.E. directly for the island, and seldom or never miss it.

Those who have lost their reckonings, on finding this gully, which may be known by the water shoaling on the East and West sides of it,—an experiment that is frequently made for ascertaining whether they are actually in it or not,—may safely take it as a fresh departure. Commanders, not being aware of it, when they have found their water deepen from the Green Bank to the Westward, have imagined themselves entering the Gulf of St. Lawrence; and, by steering a course too far to the *Northward*, have been lost on the rocks lying to the Eastward of Cape Ray.

The little island of St. Paul, which lies to the North-Eastward of Cape North, now distinguished by its lighthouses, is bold-to, steep, and high, and, with a good look-out in the daytime, cannot be considered as dangerous even in thick weather. The land of Cape Breton Island is very high, and, though fogs are about it frequently, it is seldom so much obscured as not to be seen in time. On entering the Gulf, the Magdalen and Bird Islands with their lighthouses, will be seen, as they lie in the direct course from Cape North to the River St. Lawrence.

There is, in clear weather, a safe passage between the Bird Islands and the Magdalens; but, in thick weather, it is advisable to keep either to the Southward or Northward of both, as the wind may permit.

In Pleasant Bay, on the S.E. side of Magdalen Islands, there is clear and good anchorage, very near the shore; and it is a very safe place for vessels to ride in, with a Westerly wind, and infinitely preferable to beating about in the gulf with a foul wind. There is a safe passage into it between Amherst Island and Entry Island.

As the weather to the Southward of these islands, between them and Prince Edward Island, is generally much clearer than to the North, the passage that way is preferable, particularly after the early part of the year, when S.W. winds mostly prevail.

Vessels bound to or from the River St. Lawrence now use the Strait of Belle Isle, as a channel which gives the shorter and better route to Europe *in the summer months*. It should be remembered that the Ice described in pages 450—454, which floats down the Labrador Coast to the Great Banks, must be carefully avoided during the season of its frequency in February or March to July. Again, the shorter days in the higher latitudes, and the prevailing Fogs which infest the Newfoundland coast, have to be taken into account during the winter and late autumn months. The lights on Belle Isle and Amour Point, in the Strait of Belle Isle, will very much facilitate the navigation thus pointed out. With the caution thus indicated, this route offers many advantages. The Canadian mail steamers now follow it, although an accident from Ice to one of them, in the month of May, 1861, will act as a warning.*

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* When within the gulf, the Northern shore should not be made too free with, as it is possible that some outlying rocks may have escaped the vigilance of the surveyors. *Grange Rock*, off Coacoacho Bay, is an example; the S.S. *North America* discovered it by striking on it in September, 1858. It is 1¼ mile outside the line of dangers, near a spot where the Admiralty chart showed no bottom at 47 fathoms.

10.—BETWEEN EUROPE AND NEW YORK, ETC.

There seems to be little hope that much can be added to our knowledge of this well-beaten track, and that the passages can be shortened, to any appreciable extent, by adopting any fresh route. Soon after Captain Maury's Pilot Charts appeared, an analysis was made of them in order to find out the best route by *computation* for each month in the year, of a track between New York and Europe.

It is only in quite recent years that any attempts have been made to reduce the Winds of the Northern portion of the North Atlantic to any system, and at the present time the increased knowledge is not sufficient to justify the alteration of those tracks across the Atlantic, which experience has proved to be most advantageous. In the future, when the *reason* of the superiority of one route over another, and the progressive seasonal changes of Wind, Current, &c., are more fully understood, we may expect the passage to be shortened. One feature helping in this direction we may mention, and that is the discovery of the mode of progress of the air across the British Isles in an Easterly and North-Easterly direction, as described in (128) pages 198—199.

Of the occasional progress of storms (or areas of low barometric pressure around and into which the wind blows) across the whole breadth of the Atlantic, we have good evidence, see (125) to (127), pages 189—198; and, in a recent publication of the Meteorological Office,* Captain Toynbee remarks, in speaking of the synchronous charts which illustrate that work :—"The advantage of such charts to navigators is that they give a picture of what was going on over the whole Atlantic at the same moment of time. By comparing successive charts they also show any changes which had taken place during 24 hours. For instance, the wave-like shapes of some of the isobars in high latitudes (being undulations of pressure which are followed by the wind-arrows) illustrate for the navigator the changes of barometer and wind which he so frequently experiences in these latitudes. The chart of the first shows the ridge of a wave near Iceland, whilst on the second its ridge was North of the British Islands, having passed to the Eastward at a rate of more than 20 miles an hour, and carried with it wind changes from N.W. to South.

"In a 'Report to the Committee on the Meteorology of the North Atlantic,' published by this Office, it is shown that steamers bound to America pass through a large number of these undulations, whilst those from America experience comparatively few of them (see pages 181—182). Hence a steamer bound to the Westward will have much *quicker* changes of barometer and wind than one steaming to the Eastward, because the latter is to a certain extent moving with the undulations. So that, in these latitudes, a fast-falling barometer, in a ship steaming to the Westward, is not so great a sign of bad weather as it is when steaming to the

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* Meteorology of the North Atlantic Ocean, during August, 1873, illustrating the Hurricane of that month. Published in 1878.

Eastward; because in the first case the mere speed of the ship to the Westward often increases the rate of fall of the barometer; whereas the speed of a ship to the Eastward tends to make the barometer fall more slowly than it otherwise would do, or even to rise. It is no uncommon thing for steamers bound to the Eastward to have a rising barometer with a Southerly wind, which rarely, if ever, occurs when steaming to the Westward. Of course the barometers of sailing ships are similarly affected, but, as their speed is not generally so great as that of steamers, the change is not usually to the same extent."

The work mentioned (*note*, p. 545) illustrates Buys-Ballot's Law (pages 112—115). As shown in the diagram of the Winds, a permanent area of high barometrical pressure, 800 or 900 miles in diameter, with the Azores on its Eastern margin, forms a centre around which appear to revolve smaller areas of low pressure; these areas of low pressure form the centres of the West India Cyclones, and of our Storms. In this diagram are shown the routes of some areas of low barometrical pressure, around and towards the Southern side of which the winds of Atlantic gales have been observed to blow. These are taken from the same work of Captain Toynbee. These gales do not appear to be true Revolving Storms, such as the Tropical Hurricanes, for the reason that very few observations for Easterly winds are recorded. It may be that these Easterly winds would be found to the Northward of the ordinary tracks of ships; but, as shown in the diagram, the winds have been observed to blow around the Southern side of the centre of low pressure, from the N.W., West, and S.W.

It will be needless to dilate on the Pilot Charts of Captain Maury, or to give the copious tables drawn up to illustrate the routes. These tracks certainly seem to us to diverge considerably from any regularity of order in different months, not exhibiting any gradual change with the seasons, as might reasonably be expected, but have a general zig-zag course, at variance with the generally received laws of simplicity and order which natural phenomena, governing these courses, usually assume. This want of an apparent general law of change is doubtless owing to the imperfection of the data upon which they are based.

But as these recommendations were followed out by a great number of sailing vessels, chiefly the fine clippers and passenger ships between Liverpool and New York, their voyages were discussed and tabulated by Captain Maury in his last edition, and the general *mean* result of the best six passages in each month is given in the ensuing tables.

The *computed* routes, with the probable amount of fair or head winds, gales, and calms, and distances required to be sailed over in each section of the voyage, are omitted. The tables of *actual* experience which follow will, it is thought, be quite sufficient to give an idea of the subject. Only the mean results are given here, not the details from which they are derived.

CROSSINGS AND TIME FROM THE ENGLISH AND ST. GEORGE'S CHANNELS TO NEW YORK.

MONTH.	TIME AND LATITUDES OF CROSSING THE MERIDIANS OF																									Total Days to Port.
	Days.	15°	Days.	20°	Days.	25°	Days.	30°	Days.	35°	Days.	40°	Days.	45°	Days.	50°	Days.	55°	Days.	60°	Days.	65°	Days.	70°	Days.	
		°		°		°		°		°		°		°		°		°		°		°		°		
January ...	3·7	48·5	1·3	47·2	1·4	46·5	1·7	46·0	1·7	45·0	2·0	44·7	1·9	43·5	2·1	42·6	1·6	42.0	2·7	41·5	1·9	41·6	2·2	40·2	2·1	25·7
February..	3·0	49·8	1·1	49·3	1·1	48·8	1·6	47·7	1·6	46·7	1·7	46·1	1·7	45·2	2.6	43·5	3·1	41·9	1·9	41·4	2·0	41·4	2·5	40·2	2·8	26·8
March......	3·1	49·3	1·4	48·6	1·2	47·5	1·8	46·3	1·6	44·8	1·6	43·7	2·2	42.7	1·8	42·5	1·8	42·2	2·3	41·7	1·7	41·1	1·9	40·5	1·4	23·9
April	4·2	49·5	1·4	49·0	1·6	48·4	1·5	48·1	1·8	46·7	2·1	45·9	2·5	44·8	1·7	44·1	2·2	43·7	2·4	42·6	2·4	41·7	2·3	40·8	1·5	27·7
May.........	4·2	48·3	1·3	48·2	1·5	47·5	1·7	46·3	1·6	45·6	1·7	44·6	1·7	44·2	2·0	43·2	2·0	42.3	2·0	41·7	2·2	41·2	1·9	40.4	1·4	25·2
June	3·4	51·2	1·6	50·2	2·4	49·5	1·5	48·4	2·4	47·6	2·0	46·7	3·0	45·2	2·3	44·9	2·4	43·5	1·7	43·0	2·5	42·0	2·3	41·6	1·7	28·8
July.........	5·0	50·0	2·1	48·6	1·8	47·8	2·0	46·2	2·5	46·1	2·7	44·0	2·9	44·2	4·5	44·0	2·6	43·5	2·2	42·4	1·9	41·6	2·1	40·4	1·3	32·6
August ...	4·2	48·6	1·6	48·4	1·7	48·1	1·6	47·6	1·7	46·6	1·6	46·0	2·1	45·0	2·1	44·0	1·8	44·5	2·0	42·3	1·9	41·3	2·4	40·2	1·2	25·7
September.	4·3	49·2	1·7	47·7	1·6	46·5	1·8	45·1	2·2	44·1	2·2	43·1	1·7	43·5	1·9	43·1	1·7	42·2	2·0	42·0	1·8	41·3	2·0	40·3	1·1	26·0
October ...	4·2	48·4	1·1	47·8	1·2	46·9	1·4	46·5	1·5	45·6	1·6	44·5	2·2	43·5	1·9	43·5	2·3	42·7	1·5	41·8	1·8	40·5	2·2	40·3	1·7	24·6
November .	5·1	48·7	1·4	48.1	1·6	47·5	1·2	46·5	1·6	45·6	1·4	44·5	2·6	43·2	2·0	42·4	2·4	42·5	2·2	41·6	1·7	41·3	3·2	33·2	2·8	29·3
December .	4·5	51·5	2·1	51·9	2·4	51·7	2·6	50·7	2·2	49·9	2·3	48.8	1·6	47·2	2·2	44·6	1·6	43·5	2·4	41·7	2·7	41·1	3·2	40·2	2·3	32·2

CROSSINGS AND TIME FROM NEW YORK TO THE ENGLISH AND ST. GEORGE'S CHANNELS.

MONTH.	TIME AND LATITUDES OF CROSSING THE MERIDIANS OF																						Total Days to Port.
	Days.	70°	Days.	65°	Days.	60°	Days.	55°	Days.	50°	Days.	45°	Days.	40°	Days.	35°	Days.	30°	Days.	25°	Days.	20°	Days.	15°	
		°		°		°		°		°		°		°		°		°		°		°		°	
January	1·2	40·0	1·5	40·3	1·5	40·8	1·2	41·9	1·4	43·0	1·4	44·0	1·0	45·6	1·6	46·5	1·0	47·7	1·1	48·4	1·1	49·0	1·0	49·7	18·2
February	1·0	39·9	1·7	39·9	1·4	40·1	1·6	40·4	1·4	41·5	1·4	42·7	1·2	44·4	1·2	45·4	1·1	46·7	1·4	48·1	1·1	49·0	1·4	49·2	19·2
March	1·6	40·0	2·1	39·8	1·5	40·8	1·2	41·7	1·3	42·6	1·3	43·9	1·2	45.4	1·1	46·4	1·0	47·3	1·1	48·1	1·0	48·8	1·0	49·4	18·5
April	1·5	38·8	1·1	39·7	1·4	39·9	1·2	40·6	1·3	41·6	1·4	42·8	1·2	44·4	1·2	45·9	1·2	47·2	1·2	48·6	1·1	49·7	1·2	50·6	17·4
May	1·5	40·0	1·6	40·2	1·2	40·7	1·3	41·1	1·2	42·0	1·5	43·4	1·6	44·9	1·3	45·7	1·2	46·5	1·4	47·1	1·3	48·0	1·2	48·9	19·8
June	1·2	39·8	1·8	40·1	1·6	40·7	1·4	40·9	1·4	41·3	1·3	43·2	1·0	44·2	1·4	45·8	1·2	47·0	1·0	47·9	1·2	48·5	1·5	49·0	19·6
July	1·3	40·1	1·7	40·3	1·2	41·2	1·3	42·3	1·7	43·4	1·6	44·2	1·8	45·6	1·5	46·9	1·3	48·0	1·0	47·3	1·0	49·2	1·0	49·6	19·0
August	1·5	39·7	1·7	39·5	1·6	40·3	1·7	40·8	1·7	43·1	1·7	44·2	1·5	46·0	1·0	47·0	1·2	48·7	1·2	49·1	1·1	49·4	1·1	49·5	21·0
September.......	1·3	39·8	1·3	40·2	1·4	41·1	1·7	41·4	2·0	42·0	1·6	43·8	1·1	45·0	1·2	46·6	1·1	47·7	1·2	48·4	1·0	49·0	1·0	49·7	18·7
October	1·3	40·1	1·3	40·3	1·2	41·2	1·6	42·4	1·5	42·9	1·4	44·1	1·2	44·3	1·2	46·6	1·1	47·4	1·0	48·1	1·1	49·0	1·3	49·5	18·6
November	1·2	40·0	1·5	40.0	1·3	40·5	1·4	41·3	1·5	42·5	1·4	43·7	1·5	45·3	1·2	46·6	1·2	47·7	1·5	49·0	1·3	49·7	1·4	50·5	20·2
December	1·1	39·8	1·3	40·6	1·2	40·9	1·5	42·1	1·6	42·8	1·1	43.6	1·1	44·7	1·4	46·3	1·1	47·2	1·1	48·5	1·1	49·3	1·0	49·8	17·1

These two tables give the mean track and time occupied by the best *six* of each of the sailing passages discussed as proceeding from Europe to America, and from America to Europe. The ports on the European side are London, Liverpool, Havre, and a few from the Clyde, Hamburg, &c. The last column gives the total duration of the voyage, and the intermediate day columns the time occupied in sailing between the respective meridians 5° apart.

But these six best passages of course are considerably below the average length of the ordinary voyages, which may be briefly stated as follows :—

Europe to America.—January, 19 to 82 days; mean of all, 40·1 days. February, 21 to 52 days; mean, 33·5 days. March, 21¼ to 42 days; mean, 31·5 days. April, 24 to 43 days; mean, 33·7 days. May, 18 to 47 days; mean, 32·0 days. June, 29 to 54 days; mean, 36·7 days. July, 31 to 45 days; mean, 36·8 days. August, 22 to 46¼ days; mean, 33·1 days. September, 23 to 40 days; mean, 29·1 days. October, 18¼ to 46 days; mean, 31·0 days. November, 28 to 53¼ days; mean, 37·2 days. December, 27¾ to 48 days; mean, 37·6 days.

America to Europe.—January, 17 to 28 days; mean, 21·0 days. February, 16 to 28 days; mean, 22·6 days. March, 16 to 28 days; mean, 22 days. April, 12 to 28 days; mean, 22·5 days. May, 18 to 28 days; mean, 23·2 days. June, 19 to 28 days; mean, 22·5 days. July, 17 to 27 days; mean, 21·5 days. August, 20 to 28½ days; mean, 24·1 days. September, 16 to 29 days; mean, 23·1 days. October, 16 to 27 days; mean, 21·9 days. November, 17 to 26 days; mean, 22·0 days. December, 15 to 28 days; mean, 21·2 days.

These figures will show with how much more certainty the Eastern voyage is made, with the Anti-Trade Winds and Easterly Currents in its favour, than the average Western voyage with their adverse influences to retard and embarrass it. Upon this subject see the remarks on the Atmosphere, pages 108—124, and also those by Captain Toynbee (108) to (113), pages 177—181. The progress of Storms across the Atlantic is described in (114) to (133), pages 181—203.

11.—STEAM TRACKS TO AND FROM AMERICA.

The continually increasing amount of collision, which advanced much beyond the ratio of the use of steam, led to many plans for averting it, but apparently without a corresponding effect in adopting them.* The terrors of this danger in the open sea are manifest, and many sad examples are too well known not to induce caution—one, that of the American mail-steamer *Arctic* striking the French steamer *Vesta*, near Cape Race, in October, 1854, led our American friends to consider whether some means could not be employed to lessen the danger. Accordingly, R. B. Forbes, Esq., of Boston, proposed one track for steamers *going to*, and another for those *coming from* America. This problem was worked out by Captain Maury, and his recommendations have been of great service. Owing, however, to the changed conditions of navigation, and the want of general agreement among the steamship lines, his routes are not now generally followed, being superseded by others, founded on them, and hereafter described. Captain Maury's remarks, however, are still of considerable value, and are as follows.

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* A great safeguard would be legislative enactment against high speed during fog, heavy rain, or snow:—authorizing a *majority* of passengers to make objection; to inspect, note, and sign the log, before disembarking; and, by a quorum, to give subsequent evidence.—*Admiral Fitzroy, Meteorological Papers*, 1858.

"The shortest distance possible for a steamer between Liverpool and Sandy Hook is 3,009 miles; the average distance actually accomplished is 3,069 miles; and the distance by the middle of the Lane coming Westward is 3,038. There is also another recommendation in favour of this Lane to the West, which is this: it lies along the Northern edge of the Gulf Stream, where there is an eddy setting Westward often at the rate of a knot an hour. On the average, I assume that the set of this eddy will amount to 12 miles a day for 3½ days, or say 40 miles. This makes the distance by the Lane coming Westward practically about 2,998 miles; or, allowing 20 miles for detour, we shall have 3,018 miles, which will shorten the average time of the passage this way three or four hours, with less risk of collision, and less danger from Cape Race by the way.

"It may be urged against this Lane that it cannot always be followed, on account of the Ice, and that, inasmuch as it crosses the Grand Banks, the steamers that ply in it may now and then run down a fishing vessel.* The reply is that, as far as the fishermen are concerned, they are now liable to be run down by the steamers both going and coming. Whereas, with the Lane, that liability is incident to the steamers alone that are Westwardly bound, and the fishermen will have the advantage of knowing pretty nearly where the steamer will pass, and which way she will be coming. And as for its being obstructed by Ice, so as to compel the steamers, as it occasionally will, especially in May or June, to turn out of it now and then, the Erie Canal, of New York, is obstructed by ice the whole of every winter, but that does not prove it to be of no value; it only shows that it, like this Lane, would be of more value to commerce if it were never obstructed by ice, or anything at all.

"The Grand Banks afford a pretty good landmark, which can be used in the thickest weather. Generally the water temperature is found to fall as soon as your near these Banks; it is generally a good landmark for them. The Eastern edge runs North and South, and, therefore, affords an excellent correction for longitude. Having ascertained by the lead when the vessel first strikes this edge, then noting the soundings and the distance run before clearing the Grand Banks, the latitude will also be known with accuracy sufficient to enable the navigator to decide whether he be in or out of the Lane, and, if out, on which side. The Lane crosses the Banks near their greatest width, 275 miles. If a steamer be crossing there in a fog, and in doubt as to her position, she can judge, by their breadth and the soundings, pretty nearly as to latitude. For instance, if the breadth of the Banks, when crossed, be less than 275 miles, but the soundings not less than 40 fathoms, the vessel has crossed the Bank to the North of the Lane; but if she find herself in less than 30 fathoms, then she has crossed to the South of it. Should she, however, find herself in water that suddenly shoals to less than 20 fathoms, and as suddenly deepens again, then she is near the Virgin Rocks, or the rock and Nine-fathom Bank to the East of them, and her position is immediately known.

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* The American fishing vessels put to sea about the middle of April, and in June, July, August, and September, steamers crossing the Banks should keep a good look-out for them, especially in foggy weather. At the end of September or October, they return home, and until the spring many boats lay up, or are usually limited to the George's and Brown Banks and New England shore.

" It should be recollected, however, that these Lanes are not channel-ways in which steamers must keep or be lost. Gales of wind, Ice, and other things, will now and then force a steamer out of them, and in such cases she will then be in no more danger than she is now; only when she gets back into the Lane she will be in less.

" You will doubtless observe the advantageous position of the fork to Halifax, in the Lane from Europe. As this Lane approaches Newfoundland, it edges off to the South in such a manner as to render it impossible for a vessel so to miss her way as to get ashore. Suppose a steamer attempting this Lane to be, when she nears the Grand Banks, 100 miles out in position (a most extravagant case), and that she be out on the Newfoundland side, she would, if behaving properly, be steering parallel with the Lane, and if bound to New York, she would go clear of Cape Race. But she might be bound for Halifax, and by steering West too soon, might run upon the land; but recollect that the Lane to Halifax turns off *on soundings*, and a West course from where the Lane from England strikes soundings on the Grand Banks will take you clear of everything. So without the most gross neglect of the lead and all proper precautions, which it is the duty of the shipmaster to take, it would seem impossible for him to run his steamer into danger here.

" In the longitude of the Grand Banks, the Lane to Europe is 200 miles South of the Lane to America. As a rule, this Lane for the Eastern bound steamers can be followed always, admitting that an exception now and then in practice will make the rule general. It will be observed that this Lane runs E. 15° S. from Sandy Hook to the meridian of 70°, where it takes a course E. 12° N., towards its junction with the arc of a Great Circle, South of the Grand Banks. Though the distance by this Lane, from Sandy Hook to this junction, is a few miles longer than the direct line, yet on account of the Gulf Stream it is in *time* the shortest distance that a steamer can take. From the Capes of Delaware it is obviously the shortest.

" I will close this report with a recapitulation as to distances and courses by each Lane, between New York, Halifax, and Philadelphia, on one side, and Cape Clear and the Scilly Isles on the other; first begging leave to say that, according to my computation, founded on such statistics as I have, touching the velocity of the Gulf Stream, if two steamers bound for Cape Clear, and of exactly equal speed, were to start from Halifax, to see which should first get into the Great Circle part of the Lane to

Europe from New York, and if one were to go straight for it by steering East, and the other were to follow the European Lane from Halifax as projected on the chart, this one would reach the point of destination quite as soon as the other, the drift of the Gulf Stream compensating for the greater distance.

DISTANCE IN MILES TO AMERICA.

	By Lane.	By Great Circle.
From Scilly Isles to Halifax	2,351	2,305
„ „ Capes of Delaware	2,948	2,909
„ „ Sandy Hook	2,882	2,840
From Cape Clear to Halifax	2,192	2,170
„ „ Capes of Delaware	2,789	2,765
„ „ Sandy Hook	2,723	2,695
„ „ „ by actual average	2,754	

“ This statement shows that by the Lane to America the distance is actually shorter, both to Sandy Hook, and, we may infer also, to the Delaware, than the average distance by the present route; for the route actually pursued by the steamers now, both to Sandy Hook and the Delaware, may be considered the same from Cape Clear or the Scilly Isles, as far West as long. 70°.

DISTANCE IN MILES BY LANE TO EUROPE.

	To Scilly Isles.	To Cape Clear.
From Halifax	2,436	2,285
„ Capes of Delaware	3,024	2,873
„ Sandy Hook	2,980	2,829

“ Besides the detour from the Great Circle which a vessel from New York, Halifax, Boston, or Philadelphia, would necessarily make by following the European Lane to Cape Clear, it would require an *additional* detour of only 15 miles for vessels bound into the English Channel to use it also as far as Cape Clear. This Lane, therefore, will, in consequence of the favourable currents of the Gulf Stream, put a vessel into Southampton quite as soon as she could reach that port from New York or Philadelphia by the Great Circle route. Vessels from Halifax will have to make the greatest detour of any by adopting the Lane to Europe; but for them it is less than 100 miles out of their way as they now go, and it will prolong their average passage Eastwards, perhaps two or three hours. I say *perhaps*, because I am not sure but that the steamers from Halifax and New England are set back by the cold current 20 or 30 miles on the route now used for the Eastern passage. The Gulf Stream, even from where they will join it by this Lane, will set them forward, on an average, 40 or 50 miles at the least. It seems, therefore, that the attractions of this Lane, as regards safety, should more than outweigh the *probable* loss of an hour or two during the passage. When I speak of distances by the Lanes, it should be recollected that the *middle* of the Lane is meant, as in the following table of courses and distances.

LANE TO AMERICA.

					Course (*true*).	Distance in Miles.
From Scilly Isles to Cape Clear					W. 33° 7′ N.	159
„ Cape Clear to lat. 51° 23′, long. 15° 0′					W. 1° 55′ N.	187
From	lat. ° ′	long. ° ′	to lat. ° ′	long. °		
„	51 23	15 0	51 16	20 0	W. 2° 17′ S.	187
„	51 16	20 0	50 56	25 0	W. 6° 5′ S.	189
„	50 56	25 0	50 23	30 0	W. 9° 50′ S.	193
„	50 23	30 0	49 36	35 0	W. 13° 41′ S.	199
„	49 36	35 0	48 33	40 0	W. 17° 45′ S.	207
„	48 33	40 0	47 15	45 0	W. 21° 8′ S.	216
„	47 15	45 0	45 38	50 0	W. 25° 10′ S.	228
„	45 38	50 0	45 0	51 45	W. 27° 13′ S.	83
„	(*a*) 45 0	51 45	44 10	55 0	W. 19° 45′ S.	148
„	44 10	55 0	42 40	60 0	W. 22° 27′ S.	236
„	42 40	60 0	41 42	65 0	W. 14° 34′ S.	231
„	41 42	65 0	40 30	70 0	W. 17° 45′ S.	236
„	40 30	70 0 to Sandy Hook			W. 0° 43′ S.	183
„	40 30	70 0 to Capes of Delaware			W. 22° 8′ S.	249
„	(*a*) 45 0	51 45 to Halifax			W. 3° 53′ S.	503

LANE TO EUROPE.

					Course (*true*).	Distance in Miles.
From Capes of Delaware to lat. 39° 40′, long. 70° 0′					E. 10° 46′ N.	236
„ Sandy Hook to lat. 39° 40′, long. 70° 0′					E. 14° 29′ S.	192
From	lat. ° ′	long. ° ′	to lat. ° ′	long. ° ′		
„	39 40	70 0	40 31	65 0	E. 12° 24′ N.	237
„	40 31	65 0	41 9	60 0	E. 9° 39′ N.	227
„	41 9	60 0	41 33	55 0	E. 6° 5′ N.	225
„	41 33	55 0	41 53	50 0	E. 4° 57′ N.	232
„	(*b*) 41 53	50 0	43 55	45 0	E. 29° 6′ N.	251
„	43 55	45 0	45 46	40 0	E. 27° 28 N.	241
„	45 46	40 0	47 18	35 0	E. 24° 4′ N.	226
„	47 18	35 0	48 32	30 0	E. 20° 18′ N.	212
„	48 32	30 0	49 30	25 0	E. 16° 21′ N.	206
„	49 30	25 0	50 14	20 0	E. 12° 46′ N.	199
„	50 14	20 0	50 45	15 0	E. 9° 17′ N.	192
„	50 45	15 0 to Cape Clear			E. 4° 34′ N.	189
From Cape Clear to Scilly Isles					E. 27° 39′ S.	151
(*b*) Halifax to lat. 43° 30′, long. 60° 0′					E. 20° 7′ S.	163
From lat. 43° 30′, long. 60° 0′ to lat. 42° 30′, long. 55° 0′					E. 15° 17′ S.	181
„ 42° 30′ „ 55° 0′ „ 41° 53′ „ 50° 0′					E. 9° 28′ S.	225

The Courses and Distances are for the "middle" of the Lanes.

"Thus it appears that one Lane will practically shorten the distance from Cape Clear to Sandy Hook and the Delaware by 30 miles, while the other prolongs the distance going to Europe 75 miles; which prolonged distance, when measured, not by safety, but *in time* alone, the Gulf Stream, better weather, and diminished frequency of fogs, will more than compensate for. In my judgment, these Lanes, if properly followed, will make the average length of passage, as determined by the mean of all for the year, probably less each way, certainly not more than an hour or two longer than it now is. Individual passages coming will, perhaps, not be made so quickly as they have been, but, on the average, trips will be shortened."

Admiral FitzRoy also devoted some attention to this subject, and made the following remarks, regarding Maury's "Lanes for Steamers," in his "Meteorological Papers," 1858.

"If steamers could always steer direct courses, being full-powered, and not liable to be headed off in occasional heavy seas, such an arrangement might be advantageous; but as it is otherwise, and as screw (auxiliary or mixed) ships sail while steaming, they *cannot* conveniently keep to prescribed "Lanes," however desirable it might otherwise seem.

"However, as the traffic increases between Europe and America, some special arrangement may be required, even more urgently than now; in which case it might perhaps be found practicable to consider an imaginary line, from lat. 50° and long. 20° to the crossing of 45° N. and 55° W., the "line of *separation*," Northward of which should go all vessels bound to the Westward, and South of it all those heading to the Eastward." As will be seen on pages 557—559, an arrangement has now actually been adopted to carry out this idea.

NORMAL TRACKS FOR STEAMERS.

On pages 171—177 and 196—198, we have given some extracts from an essay by Herr von W. von Freeden, Director of the Hamburg Meteorological Office, on the Winds, &c., along the Tracks of the North German Lloyd steamers. What is there given refers to the Winds; and, as an application of that investigation, we give the following Tables from the same work, for the normal tracks for each month of the year, with Herr von Freeden's remarks on the same.

It will be seen that the proposed tracks simply contain the latitude in which every tenth meridian should be crossed in the various months, as well as the *true* course, and distance in nautical miles, from one point of crossing to the next. In all cases where the routes are *variable*, 330 miles have been entered as the distance to be run from the Needles to 10° W., and 183 miles from 70° W. to Sandy Hook. Any slight difference which may have been caused by crossing these meridians on other than the fixed latitudes of 50° and 40½° N. has been considered to be of no importance.

MONTHLY NORMAL TRACKS *for the North German Lloyd Steamers running between the Lizard and New York.*

OUTWARD TRACKS.

	December.			January.			February.		
Ships from the Needles pass	Lat. N. ° ′	Distance in Miles.	Correct Course. ° ′	Lat. N. ° ′	Distance in Miles.	Correct Course. ° ′	Lat. N. ° ′	Distance in Miles.	Correct Course. ° ′
10° W.......	49 54	330	Variable.	49 54	330	Variable.	50 0	330	Variable.
20 ,, ...	49 48	383	S. 89 6 W.	50 6	387	N. 88 14 W.	50 17	385	N. 87 28 W.
30 ,, ...	49 6	392	S. 83 51 W.	49 24	390	S. 83 49 W.	49 43	387	S. 84 58 W.
40 ,, ...	47 24	412	S. 75 41 W.	47 54	406	S. 77 13 W.	48 13	404	S. 77 8 W.
50 ,, ...	45 0	440	S. 70 52 W.	45 24	438	S. 69 59 W.	45 42	436	S. 69 45 W.
60 ,, ...	42 48	452	S. 73 1 W.	42 42	461	S. 69 26 W.	42 30	472	S. 65 58 W.
70 ,, ...	40 42	465	S. 74 17 W.	40 24	470	S. 72 55 W.	40 36	468	S. 75 45 W.
	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.

	March.			April.			May.		
10° W.......	50 12	330	Variable.	49 54	330	Variable.	50 0	330	Variable.
20 ,, ...	50 30	383	N. 87 18 W.	49 40	387	S. 87 56 W.	49 48	385	S. 88 13 W.
30 ,, ...	50 0	385	S. 85 32 W.	49 4	392	S. 84 44 W.	48 50	396	S. 81 34 W.
40 ,, ...	48 20	405	S. 75 42 W.	47 36	408	S. 77 33 W.	46 50	420	S. 73 24 W.
50 ,, ...	46 0	422	S. 70 39 W.	44 42	451	S. 67 17 W.	43 42	462	S. 66 0 W.
60 ,, ...	42 20	483	S. 62 55 W.	42 30	454	S. 73 5 W.	42 30	444	S. 80 40 W.
70 ,, ...	40 48	458	S. 78 25 W.	40 42	462	S. 76 28 W.	40 36	462	S. 75 44 W.
	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.

	June.			July.			August.		
10° W.......	50 0	330	Variable.	50 0	330	Variable.	50 0	330	Variable.
20 ,, ...	50 24	385	N. 86 25 W.	50 20	385	N. 87 21 W.	50 18	385	N. 87 19 W.
30 ,, ...	49 24	391	N. 81 10 W.	49 45	387	S. 84 48 W.	49 42	387	S. 84 40 W.
40 ,, ...	46 40	433	S. 67 46 W.	48 16	404	S. 77 15 W.	47 24	420	S. 70 50 W.
50 ,, ...	44 12	446	S. 70 38 W.	45 42	437	S. 69 23 W.	44 36	449	S. 68 8 W.
60 ,, ...	42 48	443	S. 79 5 W.	42 54	461	S. 68 38 W.	42 20	456	S. 72 39 W.
70 ,, ...	40 42	465	S. 74 17 W.	40 36	468	S. 72 52 W.	40 32	463	S. 76 30 W.
	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.

	September.			October.			November.		
				Great Circle from 50° N. 10° W. to 44° N. 55° W.					
10° W.......	49 54	330	Variable.	50 0	330	Variable.	49 48	330	Variable.
15 ,, ...				50 16	193	N. 85 10 W.			
20 ,, ...	50 3	386	N. 88 40 W.	50 17*	182	N. 89 40 W.	49 38	390	S. 88 32 W.
25 ,, ...				50 16	193	S. 89 44 W.			
30 ,, ...	49 26	390	S. 84 33 W.	49 43	196	S. 80 2 W.	48 56	394	S. 83 52 W.
35 ,, ...				49 5	199	S. 79 8 W.			
40 ,, ...	47 52	407	S. 76 40 W.	48 13	205	S. 75 19 W.	47 15	413	S. 75 51 W.
45 ,, ...				47 6	213	S. 71 36 W.			
50 ,, ...	45 28	436	S. 70 43 W.	45 42	223	S. 67 57 W.	44 38	446	S. 69 22 W.
55 ,, ...				44 0	236	S. 64 20 W.			
60 ,, ...	42 54	457	S. 70 18 W.	42 54	231	S. 73 25 W.	41 50	468	S. 68 58 W.
65 ,, ...				41 48	231	S. 73 25 W.			
70 ,, ...	40 40	467	S. 73 20 W.	40 42†	231	S. 73 25 W.	40 30	458	S. 79 57 W.
	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.

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* Vertex in lat. 50° 18′ N., long. 18° 18′ W.

† In 69° W.

MONTHLY NORMAL TRACKS *for the North German Lloyd Steamers running between New York and the Lizard.*

HOMEWARD TRACKS.

	December.			January.			February.		
Ships from Sandy Hook pass	Lat. N. ° ′	Distance in Miles.	Correct Course. ° ′	Lat. N. ° ′	Distance in Miles.	Correct Course. ° ′	Lat. N. ° ′	Distance in Miles.	Correct Course. ° ′
70° W.......	40 42	183	Variable.	40 30	183	Variable.	40 30	183	Variable.
60 ,, ...	43 0	468	N. 72 0 E.	41 50	459	N. 79 57 E.	41 48	458	N. 80 12 E.
50 ,, ...	46 6	466	N. 66 30 E.	44 0	458	N. 73 31 E.	44 36	468	N. 68 59 E.
40 ,, ...	48 32	432	N. 70 15 E.	46 48	453	N. 68 15 E.	47 18	451	N. 68 56 E.
30 ,, ...	50 0	402	N. 77 20 N.	49 0	423	N. 71 50 E.	49 0	413	N. 75 42 E.
20 ,, ...	50 30	385	N. 85 32 E.	49 48	394	N. 88 0 E.	49 36	393	N. 84 45 E.
10 ,, ...	50 0	385	S. 85 32 E.	49 48	387	East.	49 40	387	N. 89 25 E.
	The Needles.	330	Variable.	The Needles.	330	Variable.	The Needles.	330	Variable.

	March.			April.			May.		
70° W.......	40 24	183	Variable.	40 30	183	Variable.	40 30	183	Variable.
60 ,, ...	41 20	440	N. 82 58 E.	41 24	456	N. 83 12 E.	41 36	457	N. 81 42 E.
50 ,, ...	43 6	457	N. 76 35 E.	43 6	456	N. 77 4 E.	42 30	449	N. 83 6 E.
40 ,, ...	45 15	449	N. 73 19 E.	45 54	460	N. 68 34 E.	45 24	465	N. 68 3 E.
30 ,, ...	48 54	463	N. 61 48 E.	48 12	431	N. 71 21 E.	47 48	437	N. 70 45 E.
20 ,, ...	50 10	397	N. 78 57 E.	49 6	400	N. 82 15 E.	49 24	408	N. 76 24 E.
10 ,, ...	50 0	385	S. 88 31 E.	49 36	365	N. 85 36 E.	49 48	390	N. 86 28 E.
	The Needles.	330	Variable.	The Needles.	330	Variable.	The Needles.	330	Variable.

	June.			July.			August.		
70° W.......	40 30	183	Variable.	40 36	183	Variable.	40 32	183	Variable.
60 ,, ...	41 36	457	N. 81 42 E.	42 0	459	N. 79 27 E.	41 34	457	N. 82 12 E.
50 ,, ...	42 42	450	N. 81 34 E.	43 48	452	N. 76 11 E.	43 15	454	N. 77 9 E.
40 ,, ...	46 6	475	N. 64 32 E.	46 48	459	N. 66 54 E.	46 24	466	N. 66 3 E.
30 ,, ...	48 40	434	N. 69 14 E.	49 0	423	N. 71 50 E.	49 15	436	N. 66 59 E.
20 ,, ...	48 48	398	N. 80 9 E.	49 54	394	N. 82 7 E.	49 54	391	N. 84 16 E.
10 ,, ...	49 48	387	East.	49 54	386	East.	49 50	381	S. 89 24 E.
	The Needles.	330	Variable.	The Needles.	330	Variable.	The Needles.	330	Variable.

	September.			October.			November.		
				Great Circle from 41° N. 65° W. to 49° 50′ N. 10° W.					
70° W.......	40 30	183	Variable.	40 30	183	Variable.	40 30	183	Variable.
65 ,, ...				41 0	229	N. 82 29 E.			
60 ,, ...	42 6	461	N. 77 58 E.	43 12	259	N. 59 23 E.	42 50	470	N. 72 39 E.
55 ,, ...				45 3	242	N. 62 46 E.			
50 ,, ...	43 50	451	N. 76 40 E.	46 34	228	N. 66 19 E.	45 40	462	N. 68 25 E.
45 ,, ...				47 49	217	N. 69 58 E.			
40 ,, ...	46 20	449	N. 70 30 E.	48 47	208	N. 73 38 E.	48 20	439	N. 68 38 E.
35 ,, ...				49 31	201	N. 77 24 E.			
30 ,, ...	48 30	426	N. 72 14 E.	50 1	196	N. 81 12 E.	49 40	401	N. 78 30 E.
25 ,, ...				50 18	194	N. 85 5 E.			
20 ,, ...	49 30	399	N. 81 20 E.	50 21*	188	N. 88 52 E.	50 20	388	N. 84 5 E.
15 ,, ...				50 12	192	S. 87 15 E.			
10 ,, ...	49 45	388	N. 87 47 E.	49 50	194	S. 83 25 E.	50 0	385	S. 87 1 E.
	The Needles.	330	Variable.	The Needles.	330	Variable.	The Needles.	330	Variable.

* Vertex in lat. 50° 21′ 7″ N., long. 21° 3′ 8″ W.

In 1883, the Royal Meteorological Institute of the Netherlands published the results of an investigation by Baron van Heerdt, into the routes taken by the large ocean mail and other steamers between the English Channel and New York, the data being obtained from many hundreds of logs. It is unnecessary here to enter into more than a *resumé* of the results, as the differences in the duration of voyages, according to the route taken, do not amount to more than a few hours.

Bound Westward.—In *December*, *January*, *February*, and *March*, those vessels which crossed the meridian of 30° W. to the Northward of lat. 50°, but which on the meridian of 50° W. kept to the South of 46° N., made quite as long voyages as those which kept to the Southward on both meridians. Those which crossed 30° W. South of lat. 50°, and 50° W. North of 46° N., made very good voyages. Those which crossed 30° W. North of 50° N., and 50° W. North of 46° N., gained an average advantage of twenty-one hours on the whole voyage.

In *April* and *May*, the most favourable route is found farther to the South. On long. 30° W., the best crossing is found to be between lat. 47½° and 50° N., and on 50° W. it is advisable to cross 50° W. South of 44½° N.

In *June*, *July*, and *August*, a more Northerly route gave the best times. Crossing 30° W. in lat. 49°, or farther Northward, and 50° W. in lat. 45°, or farther Northward, was found to give a considerable advantage over a more Southerly route.

In *September*, *October*, and *November*, it seems that a course to the South of lat. 50° N. is to be preferred in crossing 30° W. Vessels which crossed 50° W. in lat. 45½°, or farther Northward, made the best passages.

Bound Eastward.—In *January*, *February*, and *March*, the best passages were made by crossing 50° W. between lat. 44½° and 46½° N., and 30° W. between 48½° and 49½° N.

In *May* and *June*, the best routes crossed 50° W. in lat. 42½°, or farther Northward, and 30° W. in or to the Northward of 48° N.

In *July*, *August*, and *September*, the best routes crossed 50° W. in lat. 43½° N., or farther Northward, and 30° W. in or Northward of lat. 48½°.

In *November* and *December*, the best passages were made by crossing 50° W. Northward of lat. 45¾° N., and 30° W. in lat. 49°, or farther Northward.*

UNIFORM TRACKS FOR STEAMERS.

The great increase of steam traffic between Europe and North America, has rendered some special arrangement urgently necessary, for regulating the routes of vessels outward and homeward bound, to diminish the risks of collision. The initiative in this has been taken by the United States Hydrographic Office, who, in December, 1887, issued the North Atlantic

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* "Route voor Stoomschepen van het Kanaal naar New York en terug," Utrecht, 1883. The general results of this enquiry will be found translated in the *Nautical Magazine*, *November*, 1883.

separate routes proposed for vessels going Eastward and
advantages of this scheme met with cordial approval from
lantic steamship companies, and in December, 1891, a
ssued, and we here give the description, the tracks being
iagrams facing page 459.
mproved knowledge of the weather characteristics of the
c, it is found that the narrow limits of the old Lanes give
œuvring so as to avoid impending bad weather. Conse-
k is given as the *Southern limit* for vessels bound West-
er as the *Northern limit* for vessels bound Eastward. It
at the captains of all steamers will see the advisability of
outes, and that those of sailing vessels will endeavour to
uch as possible.

ard.—*From January 15th to July 14th*, both days inclu-
se from the Fastnet on the Great Circle track, but nothing
he meridian of 49° W. in lat. 42° 30′ N.; thence to Sandy
, passing 20 miles South of Nantucket lightvessel. From
nnel, from Bishop's Rock light steer a course N. 85° W.,
to the meridian of 20° W., in lat. 50° 33′ N., and thence
oute.
th to January 14th, inclusive, steer a course from the
reat Circle track, but nothing South, to cross the meridian
46° N.; thence to Sandy Hook lightvessel, keeping at
uth of Virgin Rocks and Sable Island, and 20 miles South
htvessel. From the English Channel, from Bishop's Rock
e course N. 80° W., 525 miles, to the meridian of 20° W.,
; thence following the same route.
true), and the distances in nautical miles, along these
as follows.

RTHERN ROUTE (*July 15th to January 14th*).

ck.	Course.	Miles.
o long. 49° 0′ W., lat. 46° 0′ N.	Great Circle.	1574
lat. 46° 0′, to long. 60° 0′, lat. 43° 0′	S. 69° W.	505
„ 43° 0′, „ 69° 50′, „ 40° 35′	S. 72° W.	465
„ 40° 35′, to Sandy Hook lightvessel	S. 87° W.	185
	Total Distance	2729
„ 43° 0′, to Boston outer light	S. 85° W.	484
	Total Distance to Boston	2563

UTHERN ROUTE (*January 15th to July 14th*).

o long. 49° 0′ W., lat. 42° 30′ N.	Great Circle.	1677
lat. 42° 30′, to long. 69° 50′, lat. 40° 35′	S. 88° W.	946
„ 40° 35′, to Sandy Hook lightvessel	S. 87° W.	185
	Total Distance	2808
„ 42° 30′, to Boston outer light	S. 89° W.	976
	Total Distance to Boston	2653

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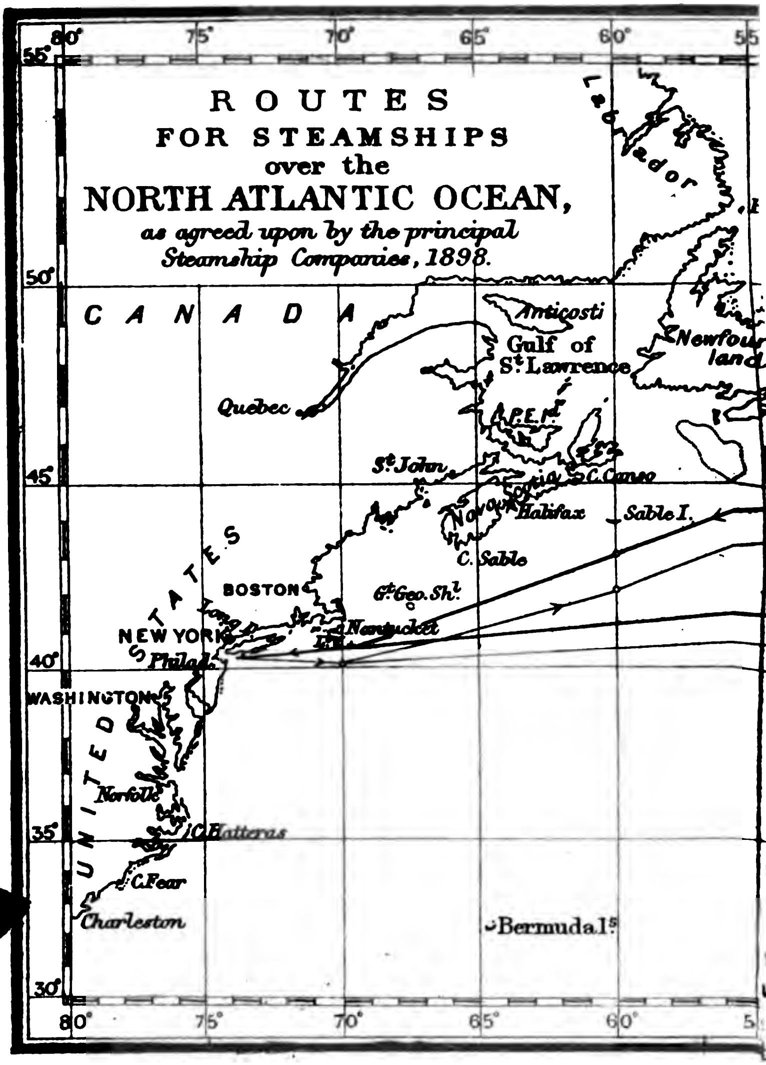


ROUTES
FOR STEAMSHIPS
over the
NORTH ATLANTIC OCEAN,
as agreed upon by the principal Steamship Companies, 1898.

... 698
... 1411
2756

... 528
... 649
... 1411
... 2588

... 179
... 960
... 1704
... 2843

... 980
... 1704
... 2684

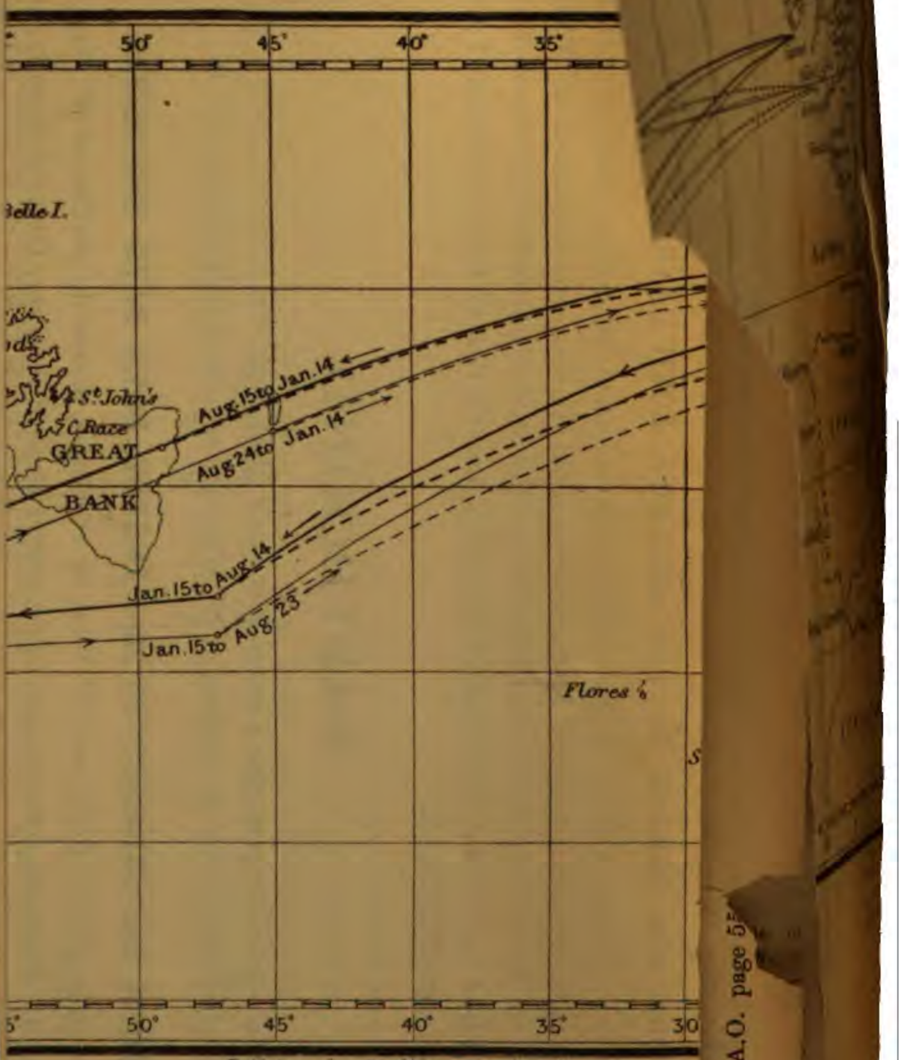
osed for
Isles.
e rhumb
join the

t. 59° N.,
t. 46° N.,

he usual
cle course

war as lat.
8° 40′ N.,

Pilot Chart with separate routes proposed for vessel
Westward. The advantages of this scheme met with
amship companies, and i



e change of Routes commences January 15th 1899, and it i
ll become the recognised Routes for all Steam Vessels *tra*
American Ports. Sailing Vessels should keep clear of the
the interests of safety for all concerned.

ry 15th to July 14th, steer a course from he meridian of 70° W. in lat. 40° 10′ N.; W. in lat. 41° 40′ N., and from this point othing North, to the Fastnet. For the route to the meridian of 20° W., in lat. 524 miles, to Bishop's Rock light.

h, steer a course from Sandy Hook light- ° W. in lat. 40° 10′ N.; then to cross the N.; then to cross the meridian of 45° W. point on the Great Circle track, but For the English Channel, follow the 20° W., in lat. 51° 7′ N., and thence ock light.

July 15th to January 14th).

	Course.	Miles.
° 0′ W., lat. 40° 10′ N....	S. 85° E. ...	179
0′, lat. 42° 5′	N. 76° E. ...	468
0′, „ 46° 30′	N. 68° E. ...	698
net	Great Circle. ...	1411
	Total Distance ...	2756
ng. 59° 0′, lat. 42° 25′	N. 89° E. ...	528
5′, to long. 45° 0′, lat. 46° 30′	N. 68° E. ...	649
30′, to the Fastnet	Great Circle. ...	1411
	Total Distance ...	2588

RN ROUTE (*January 15th to July 14th*).

	Course.	Miles.
sel to long. 70° 0′ W., lat. 40° 10′ N....	S. 85° E. ...	179
10′, to long. 49° 0′, lat. 41° 40′	N. 85° E. ...	960
40′, to the Fastnet	Great Circle. ...	1704
	Total Distance ...	2843
long. 49° 0′, lat. 41° 40′	S. 88° E. ...	980
40′, to the Fastnet	Great Circle. ...	1704
	Total Distance ...	2684

BOUT."—The following tracks are proposed for taking a route Northward of the British Isles.

rom *January 15th to July 14th*, take the rhumb ong. 14° W.; thence the Great Circle to join the 0′ N., long. 49° W.

nuary 14th, take the rhumb course to lat. 59° N., Great Circle to join the usual route in lat. 46° N.,

om *January 15th to July 14th*, take the usual 0′ N., long. 49′ W.; thence the Great Circle course 14° W.; and thence the rhumb.

nuary 14th, take the usual route as far as lat. ; thence the Great Circle course to lat. 58° 40′ N., rhumb.

As agreed to by the principal Steamship Companies, to take effect from January 15th, 1899, and now issued for general information.

Between Gibraltar, &c., and New York.—Owing to the success attending the adoption of specified routes for steamers in the Northern Atlantic, the United States Hydrographic Office, in January, 1893, issued a Supplement to the Pilot Chart, on which routes are laid down for the consideration of owners and masters of steamers trading between the Mediterranean and New York. These tracks are marked on the diagrams of Passages (page 459), and are laid down with regard to the Wind, Weather, and Currents likely to be encountered on this passage, but may be altered as experience is gained.

Briefly, the proposed routes follow the routes already established so far as concerns the region West of the 49th and 60th meridians, while East of those meridians they follow the Great Circle to (and from) Cape St. Vincent, with the addition, however, of an alternative Western route along the parallel of 34° 30′ N., from long. 20° to 65° W. This Southern route for West-bound steamers will, it is thought, be preferred during all seasons of the year by many masters, because, although 582 miles longer, it takes advantage of a decided Westerly current for about 1,500 miles, at the same time avoids the opposing Gulf Stream current, and the full force of the severe and long-continued Westerly gales and head seas that are likely to be encountered farther North, especially during winter.

The Current likely to be encountered is, of course, a factor of greater or less importance, according to the speed of the vessel, and it varies considerably during the year. Generally speaking, however, a vessel bound West along the July 15th—January 14th route may expect to encounter a Westerly current of from 10 to 20 miles a day for about 1,000 miles, and an Easterly current of from 6 to 20 miles a day for about 1,600 miles; bound West along the January 15th—July 14th route, a Westerly current of 10 to 18 miles a day for about 500 miles, and an Easterly current of 10 to 20 miles a day for about 2,000 miles; bound West along the Southern route, a Westerly current of 10 to 20 miles a day for about 1,500 miles. Finally, East-bound vessels along the route recommended for all months, will find a Westerly current of 10 to 18 miles a day for about 300 miles, and an Easterly current of 6 to 24 miles a day for about 2,500 miles.

Bound Westward.—The courses (*true*), and the distances in nautical miles, along these routes, are given as follows, those for *Westward* bound vessels first.

PROPOSED NORTHERN ROUTE (*July 15th to January 14th*).

	Course.	Miles.
Gibraltar Strait to lat. 36° 50′, long. 8° 59′ (off Cape St. Vincent)...	N. 71° W. ...	166
From off Cape St. Vincent to lat. 43° 0′, long. 60° 0′	Great Circle. ...	2340
„ lat. 43° 0′, long. 60° 0′, to Sandy Hook lightvessel...	Courses as before (p. 558)...	650
	Total Distance ...	3156

PROPOSED NORTHERN ROUTE (*January 15th to July 14th*).

Gibraltar Strait to a position off Cape St. Vincent, as above ...	N. 71° W. ...	166
From off Cape St. Vincent to lat. 42° 30′ N., long. 49° 0′ W. ...	Great Circle. ...	1861
„ lat. 42° 30′, long. 49° 0′, to Sandy Hook lightvessel...	Courses as before (p. 558)...	1131
	Total Distance ...	3158

Proposed Southern Route (*All the year*).

	Course.	Miles.
From Gibraltar Strait to lat. 34° 30′ N., long. 35° 0′ W.	S. 86° W. ...	1443
„ lat. 34° 30′, long. 35° 0′, to lat. 34° 30′, long. 65° 0′ W. ...	West ...	1487
„ „ 34° 30′, „ 65° 0′, „ 36° 0′, „ 70° 0′ ...	N. 70° W. ...	262
„ „ 36° 0′, „ 70° 0′, to Sandy Hook lightvessel	N. 34° W. ...	323
	Total Distance ...	3515

Bound Eastward.—One route is proposed for steamers bound Eastward, during all months of the year, passing Southward of the routes proposed for vessels bound Westward. The courses (true) and distances are:—

		Miles.
Sandy Hook lightvessel to lat. 41° 40′, long. 49° 0′...	Courses as before (p. 559)...	1138
From lat. 41° 40′, long. 49° 0′, to lat. 36° 50′, long. 8° 59′ ...	... Great Circle. ...	1865
„ off Cape St. Vincent to Gibraltar Strait	S. 71° E. ...	166
	Total Distance ...	3169

12.—FROM THE UNITED STATES TO THE EQUATOR.

In pages 475—501, the passage from Europe to Southern latitudes was discussed, and it was there shown that a more *Westerly* crossing than had heretofore been usual has been attended with great advantage. To those pages we therefore refer the reader, for the arguments which equally apply to the voyage from the Western side of the Atlantic.

One of the great results of Captain Maury's inquiries was the improvement of this route; and before such a mass of evidence had been collected he recommended the Great Circle route to the longitude of 31° W. on the Equator, as alluded to on page 495. This route, considered in connection with the direction of the Winds and Currents, is that which would naturally be chosen, if the crossing in that longitude would be considered to be a safe one, to guard against being drifted to leeward of Cape St. Roque. Later experience has shown this fear to be fallacious in a great measure, and it seldom occurs that vessels get into difficulties here.

Captain Maury devotes 220 pages of closely printed matter to this question; but we shall only briefly select the prominent points elicited:—

Off St. Roque the tracks of all sailing vessels bound out of the North Atlantic Ocean into the Southern hemisphere fall in with each other. This is the great passway between the North Atlantic and the other great oceans of the world. Here the tracks of vessels, both from Europe and America, come together, whether their destination be around either Cape Horn or the Cape of Good Hope. Passing the offings of this great promontory of Brasil, the highway then forks. All vessels for India, China, or Australia, hugging the wind, turn off to the East; those that are bound around Cape Horn keep straight on; while those that are bound to the La Plata, to Rio, or to any of the South American ports, being restricted in their courses by the winds on one hand and the land on the other, make the best of their way South, and turn off to the right as they reach the proper parallel.

The following Time Table, by the New Route, the Old, and the Middle, is derived from the logs of 1,160 voyages, and it therefore may be held to embody the experience of 1,160 navigators touching the best route hence to the "fairway off St. Roque." The meaning of this table is so plain that analysis and discussion can add but little to the force of its own silent story. It shows, for each month, the average time from port to 30° N.; the place of crossing that parallel, and the time thence to the Equator, and the place of crossing it, also, by each of the three routes. It shows, also, the distance from 30° N. to the Equator, and the average number of miles "made good" daily, for so much of each route as is included between these parallels.

MONTH AND ROUTE.	LONG. OF CROSSING—		DAYS FROM—		Distance from 30° N. to Line.	
	30° N.	Line.	Port to 30° N.	30° N. to Line.		
	Longitude. °	*Longitude.* °	*Days.*	*Days.*	*Total Miles.*	*Average per day.*
December ...Old	32·2 W.	25·5 W.	18·9	20·4	1835	89
„ Middle...	36·6	29·1	12·5	20·5	1860	90
„ New......	44·7	31·5	10·8	15·0	1965	131
January......Old	34·3	24·4	17·1	17·4	1885	108
„ Middle...	34·5	28·1	16·2	14·9	1830	125
„ New......	43·2	30·0	10·9	14·3	1960	137
February ...Old	29·5	22·6	16·6	23·2	1835	79
„ Middle...	35·1	25·6	15·7	14·6	1870	128
„ New......	42·5	30·2	11·8	14·3	1940	135
March ......Old	31·2	23·7	16·4	20·9	1860	89
„ Middle...	33·0	28·2	14·2	17·2	1820	106
„ New......	42·5	29·0	11·5	16·3	1970	121
April ....Old	32·4	25·6	17·2	18·1	1835	101
„ Middle...	33·2	28·1	16·7	17·2	1825	106
„ New......	40·6	29·9	13·7	15·8	1910	121
May ....Old	33·0	24·0	22·8	19·4	1865	86
„ Middle...	36·4	29·1	19·5	20·2	1855	92
„ New......	41·2	31·0	12·9	16·5	1890	114
June...........Old	32·7	26·4	21·1	23·6	1830	78
„ Middle...	39·5	28·2	17·6	21·4	1920	90
„ New......	43·5	30·7	13·8	21·2	1945	92
July...........Old	31·6	24·2	24·6	20·3	1850	91
„ Middle...	42·1	27·7	15·8	24·4	1990	82
„ New......	45·2	30·5	13·0	20·5	2000	97
August ......Old	31·6	25·3	22·0	22·0	1830	83
„ Middle...	41·4	26·7	16·0	22·2	2000	90
„ New......	45·7	30·4	14·2	24·4	2010	82
September...Old	33·8	25·2	19·3	23·0	1867	81
„ Middle...	38·8	29·0	16·8	25·6	1880	73
„ New......	41·7	31·5	15·8	16·4	1890	115
October ......Old	28·9	26·7	19·0	20·7	1810	87
„ Middle...	33·0	29·5	16·0	20·0	1815	90
„ New......	43·0	31·7	12·6	21·9	1930	88
November...Old	32·0	25·8	17·7	18·9	1830	97
„ Middle...	34·4	28·9	20·2	18·8	1825	94
„ New......	42·5	30·7	11·8	18·7	1940	104

The daily distances give to the navigator practically the best idea possible as to the difference in the winds by these several routes as they cross the N.E. Trade Wind belt, supposing that belt to lie all the year round between the Equator and the parallel of 30° North. Thus, in some months, as in October, for instance, there appears to be practically no difference in the winds, the average rate of sailing being 87 miles per day by the Old route, 88 by the New, and 90 by the Middle—a difference purely accidental, for the N.E. Trades are, at this season, pretty nearly broken up. The gain by the New Route, for this month, is not in crossing the Trade Wind belt, but in reaching it. It takes, from our Atlantic ports, 12·6 days to reach it by the New Route, 19 by the Old, and 16 by the Middle; and having crossed 30° N., the Trade Winds thence to the Equator, at this season, are the same for all routes. Not so at other seasons.

From 30° N. to the Line, the average distance sailed daily during the winter months is 92 miles by the Old route against 134 by the New. To what is this difference owing? Are the ships that take the New Route the faster? That can hardly be. They are better navigated I have no doubt, for, as a rule, the log books show that. But still that is not sufficient to account for all this difference. In winter, a ship that takes the New Route from 30° to the Line will go nearly as far, on the average, in one day as she could go in a day and a half by the Old Route. This is owing, in a great measure, to the fact that the New Route lies through a region of the ocean where the breezes are brisk, and brisk breezes always help to make both officers and crew brisk. This great difference of time and speed is probably owing to this circumstance more than to any other."

By a reference to the diagrams accompanying this Section, it will be readily seen what route it is advisable to take, according to the season.

SECTION III.

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DESCRIPTIONS OF THE COASTS AND ISLANDS OF THE NORTH ATLANTIC OCEAN.

☞ The BEARINGS and COURSES are those by COMPASS, unless where otherwise expressed; those given thus [*W.S.W.*] signify the TRUE; and the given direction of Wind, Tide, and Current is to be considered as the TRUE.

1.—ENGLAND, IRELAND, FRANCE, SPAIN, AND PORTUGAL.

It would be beyond the limits and scope of the present work to enter into such minute description and directions for the extensive line of coast of North-Western Europe, as would be sufficient guide to the mariner; such details must be sought for in the special Sailing Directions which accompany each chart, and where all necessary instructions are given. This book being specially concerned with the general navigation and phenomena of the Ocean, only those more prominent features sought for in an over-sea voyage in the more frequented coasts, or those which may not be given in any other of our publications, are here alluded to.

THE ENGLISH CHANNEL is amply described in our Sailing Directions for the same, and on pages 462 to 467, *ante*, are given some useful remarks as to its general navigation, with which most sailors are well acquainted.

DUNGENESS.—From the Strait of Dover westward, the first place where shelter may be found on the English coast is eastward or westward of Dungeness, according to the wind. Dungeness, 20 miles W.S.W. from the South Foreland, and 12¼ miles S.W. by W. from Folkestone, forms a remarkable shingle point, projecting 4 miles in a S.S.E. direction beyond the general line of the coast, with deep water close off it. It is well marked by a lighthouse and beacon, and besides these there are some fishermen's cottages, a *Lloyd's Signal Station*, *Lifeboat*, &c.*

The LIGHTHOUSE is a circular tower, 92 ft. high, painted in red and white rings, situated about 450 yards within high-water mark. The light is *fixed bright*, elevated 107 ft., and visible 16 miles seaward, between

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* *Lloyd's Signal Stations.*—Besides that on Dungeness, there are other stations on the South Coast, at St. Mary's (Scilly Islands), the Lizard, Prawle Point, St. Catherine Point, Beachy Head, Dover, Deal, and the North Foreland.

N.E. by E. ¼ E. and West. Toward the *East Bay* the light is coloured *red* between N.E. by E. ¼ E. and the land, to mark the anchoring ground; and towards the *West Bay* the light shows *red* between West and the land, to mark the limits of the anchoring ground on that side of the ness.

Lower Light.—In consequence of the ness gradually extending seaward, an additional lighthouse has been placed 225 yards S.E. by S. ½ S. from the high lighthouse, and shows a *flashing bright* light, with a quick flash of 2 seconds duration every 5 seconds. The light is elevated 28 ft., and visible 10 miles, between the same bearings as the high light.

Fog Signal.—In foggy weather a *Siren* of great power is sounded from the low lighthouse. It gives *two* blasts in quick succession every 2 minutes, the first blast being a high note, the second a low note.

A Beacon, consisting of a mast 59 ft. high, surmounted by *two globes* placed vertically, and painted *black*, stands E. by S. ½ S. from the high lighthouse, and a few yards above high-water mark, to show the extremity of the beach.

Pilots for the River Thames and North Sea ports will be found cruising off Dungeness. In September, 1891, the Trinity House stationed a steam pilot-vessel here, with pilots for London on board, in place of the sailing vessels previously cruising between Dungeness and Folkestone, though a ketch-rigged pilot-boat is still maintained off Folkestone, well out in the fairway. By night the steamer shows a *red* light* 6 ft. below the bright masthead light, and burns two flare lights in quick succession every 15 minutes. In addition to the usual fog signals, a steam Whistle will sound *four* short blasts in quick succession every 2 minutes, two low notes followed by two high notes.

Anchorage.—Dungeness has excellent anchorage on either side of it, according to the direction of the wind, but if the latter has any southing of E. by S. in it, there is no shelter in either bay. The quality of bottom in both bays is fine sand over clay and mud, and excellent holding ground throughout. Immediately off the ness the ground is foul.

The *East Bay* is sheltered from westerly winds between S.W. and N. by E., with depths of 4 to 12 fathoms. A good position is in 7 fathoms, with the lighthouse bearing S.W. by W. ¼ W., distant 2½ miles, and Lydd church just open northward of Battery No. 2, W.N.W.

In the *West Bay* the only off-lying bank is a narrow ridge of sand called *Stephenson* or *Chapel Bank*, of 19 ft. least water, its eastern end lying about 3½ miles W. by S. from Dungeness lighthouse. Fairlight church and the highest part of Fairlight Down in line, W. by N. ¾ N., will carry you well to the southward of it. This bay is well sheltered from winds between North and E. by S., and the best berth will be found in 5 or 6 fathoms, 5½ miles West of Dungeness lighthouse, with Romney church tower on with Lydd church, N.E. ¾ E. Small vessels can go farther in, guarding always against a sudden shift of wind.

Tides.—It is high water at Dungeness, on full and change, at $10^h 45^m$; springs rise 21¾ ft., and neaps 19 ft., being nearly the largest rise along this coast. The tide stream, both ebb and flood, sets past the ness and fairly through the bays, along the 7-fathoms line, at the rate of 2½ miles an hour on springs, and 1¼ mile on neaps, gradually decreasing to half this strength as you approach the shore into 3 fathoms. The western tide runs easy, and affords a good slack for running or working in.

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* This light is only experimental, and alterations may be made hereafter.

The Royal Sovereign Shoals are a number of rocky banks which lie directly in the track of vessels proceeding between Dungeness and Beachy Head. The principal shoals are, the Royal Sovereign, Horse of Willingdon, Elphick Tree, Rattan Shoal, Kinsman's Nab, Long Shoal, and Southern Head. The *Royal Sovereign*, by far the most formidable of this group, has only 9 ft. water on it, and being 6½ miles from the point, it is very dangerous. It bears E. by S. ½ S., 6½ miles, from Beachy Head Signal Station; S.E. ½ S., 4½ miles, from Langley Point; and E.S.E., 2 miles, from the Horse of Willingdon Shoal of 3 fathoms.

The Lightvessel, marking the outer side of these shoals, is moored in 11½ fathoms water, three-quarters of a mile southward of the Southern Head of 4 fathoms, with Lighthouse Cliff just open of Beachy Head, N.W. by W. ½ W.; the Royal Sovereign buoy N. ½ W., distant 1¾ mile; and Dungeness E. by N. ½ N., 23½ miles. The light shows *three bright flashes* in quick succession every 45 seconds, divided by two eclipses of 2½ seconds, and followed by an eclipse of 35½ seconds, elevated 38 ft., and visible 11 miles. In foggy weather a *Siren* sounds *two blasts* every 45 seconds, separated by an interval of 2½ seconds, and followed by 39 seconds silence.

Seaford Cliff, kept in sight to the southward of the pitch of Beachy Head, will lead at least 2 miles to the southward of the Royal Sovereign Shoals. Beachy Head light, kept open of the next eastern cliff, also leads outside all the shoals. Fairlight Mill, in a line with the N.W. part of the cliff eastward of Hastings, leads to the eastward of them.

BEACHY HEAD is a fine bold chalk cliff, 550 ft. high, surmounted by a *Signal Station*, and the line of cliffs to the westward are known as the *Seven Sisters.*

The Lighthouse, 1½ mile westward of the Station, is a white tower 47 ft. high, showing a *revolving bright* light, every 15 seconds, elevated 284 ft., and visible 23 miles. In coming from the eastward the light does not open out till bearing N.W. by W. ½ W., thus leading southward of the Royal Sovereign Shoals.

From Beachy Head lighthouse to the lightvessel marking the S.E. part or Elbow of the Owers, the bearing and distance are W. ¾ N., 35 miles; and to St. Catherine's Point, on the same bearing, the distance is 59 miles. From Beachy Head to Selsea Bill, the coast trends in a curve; but the direct bearing and distance are W. by N. ½ N., 38½ miles.

Seaford Road.—Between Shoreham and Beachy Head the depths very gradually decrease from the offing towards the land, and vessels may anchor all along the coast with off-shore winds in from 4 to 9 fathoms water; but the anchorage of most general resort is that in Seaford Road, which lies between the tide-mill which stands to the eastward of Newhaven and the Martello Tower near the beach at Seaford. The best anchorage in the road is in about 7 fathoms, between the tower and Blatchington Battery, with Beachy Head lighthouse just shut in by the cliffs, over a bottom of sand, shells, and mud. At this anchorage Beachy Head Cliffs will afford shelter with the wind as far southerly as E.S.E., and it is therefore superior to the western bay of Dungeness. *Seaford Head* is often mistaken for Beachy Head by vessels coming up Channel within 4 or 5 miles of the land; they may however be distinguished by the coastguard houses on the highest part of Beachy Head, whereas there is nothing on the former but a conspicuous large green patch on the face of the cliff.

Newhaven Harbour, lying halfway between the Downs and Spithead, and near the track of vessels working up or down Channel, derives great importance from its position. Originally formed by the mouth of the River Ouse, it has been largely extended by the construction of a massive breakwater extending off the fort on its western side, and a pier on the other side. It has a least depth of 10 ft. in the entrance at low water springs, and the tide here rises 20 feet. Dredging is constantly going on for deepening and improving the harbour. There are facilities for the repair of vessels and their machinery, including a gridiron capable of taking a vessel 218 ft. in length. Coal can also be easily obtained and shipped here. A powerful steam-tug is always available, and licensed pilots are in constant readiness.

At 7 miles N.W. by W. from Newhaven is the town of *Brighton*, the lights of which are conspicuous at night; and at the same distance beyond this is *Worthing*, another watering place, and this part of the coast is generally very low. At 5 miles to the N.N.E. of Worthing is *Chanctonberry Ring*, a large circular thick grove of trees 964 ft. above the sea, and frequently the first object seen on making the land. A reference to this object would often assist the mariner when all other objects are too low or indistinct to be observed.

Shoreham Harbour, midway between Brighton and Worthing, is formed at the mouth of the River Adur, and is capable of admitting vessels of considerable size, the entrance having a depth of 20½ ft. at high water springs, and 15 ft. at neaps. The harbour is divided into two arms by the pier which faces the entrance; in the western arm the depth is 16 to 22 ft. at high water, and vessels drawing 7½ ft. can lie afloat at low water springs. The eastern arm has depths of 17 to 19 ft. at high water, and into it opens a canal, 1¼ mile long, with an entrance lock 33 ft. wide and 175 ft. long; vessels not drawing over 16 ft. can always lie afloat under the lock gates. There are facilities for the repair of small vessels and their machinery. Vessels can anchor off the harbour, in 4 to 7 fathoms, stiff blue clay or clean sand, the water shoaling gradually towards the entrance. Pilots and a steam-tug are always in readiness.

At 17 miles beyond Worthing is *Selsea Bill*, off which runs the line of shoals marked at its S.E. point by the *Owers Lightvessel*, which shows a *revolving* light, every half-minute, alternately *red* and *bright*.

SPITHEAD, the well known anchorage, is protected by the banks extending off the eastern end of the Isle of Wight and the adjacent coast. The approaches are well buoyed and lighted, and offer few difficulties to the careful navigator. The limits of the best anchorage at Spithead are Southsea Castle bearing from N.E. to E. by N., and Gilkicker Point

N.N.W. to N.W. A good berth for large ships is in 10 to 12 fathoms, with Southsea Castle lighthouse on with the North side of the Spit Fort, N.E. by E. ¼ E., and Kickergill Tower on with a red and white mark on the western end of Monkton Barracks, N.N.W. Smaller vessels may berth themselves nearer to the Spit Sand, in about 7 fathoms, care being taken not to open Kickergill Tower eastward of the East end of Monkton Barracks. When vessels are moored they should have open hawse to the southward.

Portsmouth Harbour, noted chiefly for its extensive dockyard, is approached by the channel between the Spit and Horse Sands. Its entrance is 250 yards wide, within which it widens out into a large basin, in the navigable part of which the depths vary from 3 to 8 fathoms.

Southampton Water, opposite the northern end of the Isle of Wight, forms a completely landlocked harbour, suitable for vessels of the largest size, which can reach the town of Southampton. The peculiarity of the double tide here is noticed on page 286.

SOUTHAMPTON has of late years regained some of its old commercial importance, the construction of spacious and convenient docks having resulted in attracting hither several lines of the large Trans-atlantic steamers. There is every facility for the repair of vessels and their machinery, including large dry docks, and coal is stored in large quantities for the use of steamers. A channel has been dredged to a depth of 26 ft. at low water up to the Empress Dock entrance, and it is to be increased to 30 ft.; the minimum depth in this dock is 26 ft. at low water.

From the Owers lightvessel, *Dunnose*, the S.E. part of the *Isle of Wight*, bears W. by N., distant 19 miles, and from hence to St. Catherine's Point, the coast is hilly. To the northward of *Ventnor* are the conspicuous hills about Appuldercombe, with an obelisk on one end, and a semaphore tower on another. Near the lighthouse on St. Catherine's Point is a *Lloyd's Signal Station.*

ST. CATHERINE'S POINT LIGHTHOUSE is a stone tower, 84 ft. high, showing a *revolving bright electric* light, once every half-minute, elevated 134 ft., and visible 17 miles. Between N.W. ¾ W. and N.W. ⅛ N., the light is *red*, and a powerful *fixed red* light is visible between the flashes; this is to warn vessels that they are approaching too near the coast, in the vicinity of the *Atherfield Ledges* and other dangers, where so many disastrous wrecks have occurred.

In foggy weather too much caution cannot be exercised when a vessel is known to be near this dangerous coast. At such times a *Siren* near the lighthouse sounds *two* quick blasts in every minute, the first a high note, the second low.

Between the Isle of Wight and St. Alban's Head the coast forms a large bay, in the western part of which is the entrance to *Poole Harbour.* In the southern part of *Poole Bay* the ground is clear, and there is an open anchorage in 6 or 7 fathoms water, over sand and gravel, with Studland Church bearing West, distant 1½ or 2 miles. In the northern part of the bay, however, are several patches of dangerous rocks, with 6 and 7 fathoms between them.

St. Alban's Head is bold, and 360 ft. high, but the ground about it is foul. Between it and *Durlstone Head*, 4 miles to the eastward, the coast consists of dark limestone cliffs.

Anvil Point Lighthouse, at the western part of Durlstone Head, is a white building 39 ft. high, showing a *flashing bright* light once every 10 seconds, elevated 149 ft., and visible 18 miles. It is obscured by the land over Poole Bay. In foggy weather an explosive signal gives a report like a *Gun*, once every 10 minutes.

PORTLAND HARBOUR lies between Weymouth and the Portland Breakwater, which abuts on to the N.E. point of the island, and runs off shore in a direct line E. by N., for 3,500 ft.; but at the distance of 2,000 ft. from the shore is an opening 400 ft. wide, between two circular heads of masonry, which can be used by vessels of any size. From the eastern end it curves round to a N.N.E. direction for 5,600 ft., making the total length of the breakwater 3,000 yards. Its outer extremity is in 8 or 9 fathoms water, and the area enclosed, sheltered from every wind, covers 4,300 acres, with depths of 3 to 9 fathoms, excellent holding ground. Several hulks are moored in the harbour, from which steamers can readily obtain supplies of coal in any quantity.

A circular fort forms the northern end of the breakwater, and on this is shown a *flashing red light*, one flash every 5 seconds, which is however not visible to the southward between S.S.W. and W. by S. ½ S., being obscured by Portland peninsula. It is also obscured to the westward by the Chesil Bank, to an observer 15 ft. above the sea, when he is within 2 or 2½ miles of the bank, and the light bearing between E. by N. ½ N. and E.S.E. A *Bell* is sounded in foggy weather. Vessels, in passing, should keep not less than a cable's length eastward of the light.*

The *Bill*, or southernmost point of Portland, lies 16 miles W. ½ N. from St. Alban's Head, and about 3½ miles to the southward of the North point of the isle. It has a white obelisk on its extremity, and half a mile within it are two white lighthouses.

At Night the leading mark between the Shambles and the Bill is the two *fixed bright* lights on Portland Bill in one, N.W. by N., until the *red* light on the breakwater bears N. by E. ¾ E., when steer for it, taking care to keep a safe offing when approaching Grove Point, and a prudent distance when passing the breakwater. During the eastern stream, the higher light should be kept open to the westward of the lower one, as that stream sets with great velocity over the Shambles; and as the western stream sets as strongly into the Race, similar precautionary measures should be taken not to be set to the westward. With a sailing vessel, and the wind scant, it would be advisable not to use this passage, but to pass eastward of the Shambles.

Shambles.—The eastern end of the Shambles, a dangerous shoal, of coarse shingle, sand, and shells, bears from St. Alban's Head W. ½ S., 12 miles, and from the Bill of Portland E.S.E., 4½ miles. The bank extends thence W. ½ N., 2 miles, and the West end lies with the Bill of

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* Between the fort and Bincleave Point to N.W. by N., some harbour works in progress are temporarily marked by vessels carrying lights.

Portland N.W. ¾ W., 2¼ miles. It is steep all round, having 12 to 14 fathoms close to it; but always shows itself by a break or ripple, even in fine weather. On its East and West ends there is from 6 to 7 fathoms; but, near the middle, there is only 11 ft. at low water. The tide rises over it about 10 ft. perpendicular. Its eastern end is marked by a *light-vessel,* showing a *group-flashing* light, and in fogs a *Siren* is sounded.

TOR BAY.—*Berry Head,* the southern point of Tor Bay, lies 39¼ miles W. ¾ N. from Portland Bill; between it and *Hob's Nose* the entrance is 3¾ miles wide, and the ground within is generally clear and good, with depths of 6 fathoms and under. In sailing in, you may, if necessary, keep close either to Berry Head or the Orestone. To sail between the Orestone and Loadstone, keep nearly in mid-channel, taking care not to approach too near the West side of the Orestone, as the water is shoal for half a cable's length from the rock on that side. At a little more than 1 cable S.W. by S. from the Orestone, there is a sunken rock, with only 6 or 8 ft. over it at low water.

Ships may anchor in Tor Bay in 6, 7, 8, and 9 fathoms; the ground is strong clay and remarkably good. The common marks for anchoring are, Berry Head South, S. by E., or S.S.E., and Brixham Church on with the pier-head, S.W. The best ground is about a mile from Brixham pier-head, in 7 fathoms; but ships may ride, well sheltered, on the North side. A great swell is forced into the bay by easterly winds; but, about 1½ mile from Brixham pier-head, there is an underset to windward, by means of which ships ride easier than in other parts of the bay. In general, the deeper you anchor in the bay, the better will be the riding, being more out of the stream. From the middle of the bay, in 6 fathoms, Berry Head bears S. by E. ½ E., and the Orestone E.N.E. Small vessels commonly lie aground at Brixham, on the South side, and at Torquay, on the North side, of the bay.

DARTMOUTH HARBOUR.—The entrance to Dartmouth lies nearly 5 miles S.W. by W. from Berry Head, and about 7½ miles to the N.E. of the Start Point. It is only 220 yards in width in its narrowest part, with high and rocky land on each side, on the western side being a battery, and the picturesque old church of St. Petrox. Within the entrance the harbour widens out, with depths of 13 to 7 fathoms, as far as the town of Dartmouth, affording excellent anchorage, sheltered from all winds; vessels of the largest size can enter or leave at any time of tide. Coal is stored here in large quantities for the use of steamers, and there are facilities for the repair of vessels and their machinery, with several grid-irons available for those drawing up to 14 ft. water. A powerful steam-tug is always available.

Numerous rugged rocks, both above and below the water, lie on either side of the approach to the harbour. The largest and most conspicuous is the *Mewstone,* 125 ft. high, lying off the eastern shore; and on the high land, about 1,140 yards to N. by W. ½ W., is a conspicuous octagonal granite *beacon* tower, 80 ft. high, and elevated about 500 ft. above the sea. Some small detached high rocks lie westward of the Mewstone, and beyond these are the *Vertical Rocks,* some drying at the last quarter ebb, and so named from their precipitous sides, there being deep water close to them. *West Rock*, two-thirds of a cable farther on, only dries at very low tides; it lies 2¼ cables W. ¾ N. from the southern point of the Mewstone.

Castle Ledge, lying 2 cables off Inner Froward Point, has only 8 ft. water over it, and is marked by a *black buoy* moored 100 yards outside it. Battery and Kingswear Points touching, N.N.W., lead to the eastward of it, up to Castle Point. Beacon Hill in one with Kingswear Castle, and outside Inner Froward Point, N.W. by N. ½ N., leads clear inside Old Castle Rock, and outside the Verticals, West Rock, and the Bear's Tail.

The Mewstone, Shooter, Bear's Tail, Castle Ledge, and the Blackstone on the western side of the entrance, all lie in one line.

Pin Rock, a formidable rock of 13 ft., 4¼ cables S. by E. ¼ E. from the Blackstone, was blasted away in June, 1865, and now has 4½ fathoms water over it. At one-third of a mile eastward of Pin Rock, and 2½ cables off Combe Point, is the *Homestone*, with only 4½ ft. over it at low water, and marked by a *buoy* about 100 yards to the S.E.

Ships coming in from sea, if obliged to wait for an opportunity of entering, generally anchor without, in the part called the *Range*, which has depths of 7 to 10 fathoms. Here they lie safely when the wind does not blow in; and when it does, it will lead into the harbour. Pilots are always ready; a signal may, therefore, be hoisted for one when approaching the Range.

The fairway mark leading up to Battery Point is the flagstaff of Dartmouth Castle on with a large house on Mount Boon, N.N.W., or Battery and Kingswear Points touching.

Kingswear Lighthouse shows a *fixed* light, *bright* in the fairway, *green* on the West side of the fairway, and *red* on the East. This light in line with a *fixed bright* light 110 ft. seaward of it, and bearing N. by W. ¼ W., leads in the fairway. Other lights are shown farther in.

To sail in from the eastward, with a leading wind, from off the Mewstone steer for Combe Point, until you bring Kingswear Point on with Dartmouth Castle; thence, by steering with this mark on, you will clear Castle Ledge. When nearly abreast of the Blackstone, and having left the *buoy* off Castle Ledge on the starboard side, keep the castle open on the port bow, and pass eastward of the *buoy* marking the *Checkstone*, whence you may run in and anchor.

To sail in from the westward, with a leading wind, give a good berth to *Combe Rocks*, which lie off the shore on the West side, the outer rock drying at half-ebb, with deep water close to it; then steer to the eastward, until St. Petrox Church comes open of Blackstone Point, N. ½ E. This mark kept on will carry you clear of the *Homestone*, and the shoal water eastward of it. With Stoke Church shut in, you will have passed the Homestone, and may steer for the Blackstone. Having passed the latter, keep Dartmouth Castle on the port bow, and proceed as above.

For sailing ships, great inconvenience attends the ingress to, and egress from, Dartmouth Harbour, in consequence of the frequent and violent flaws of wind, which issue very suddenly from the high lands. Therefore, no square-rigged vessel should attempt to enter or leave the harbour without a leading wind, or the aid of a tug. Between S.W. and S.E. the winds blow truly in, and as truly out when between N.W. and N.E. Even cutters cannot always succeed in getting to sea with S.W. winds. These remarks of course do not affect steamers.

START POINT, much used as a landfall by vessels approaching the English Channel from the S.W., may be easily known from its rugged cock's-comb-like appearance, having five hillocks within the lighthouse, each about 200 ft. in height. Peartree Head, within the point, rises to 386 feet. In the vicinity of its projecting points, to the South and S.W., are the Pear Tree, Start, and Cherrick Rocks; the latter lies upwards of 2 cables S. ¾ W. from the point, and is just awash at low water springs. A sunken rock, with only 12 ft. water over it, also lies at the same distance S.E. ½ S. from the lighthouse.

The Lighthouse, at 140 yards from the extreme point of the Start, is a stone tower 92 ft. high, exhibiting a powerful *revolving bright* light, once every minute, at an elevation of 204 ft. above high water, and visible 20 miles. A *fixed bright* light is also shown in the same tower, 181 ft. above high water, over Skerries Bank, between N.E. ½ E. and E. ½ S., to guide vessels to Dartmouth and Berry Head. In foggy weather a *Siren* sounds *three* blasts in quick succession every 3 minutes, a low note between two high notes.

To the north-eastward of the Start lies the dangerous bank of pulverised shells and fine gravel, called the *Skerries*, marked by a *bell buoy* off the N.E. end. To avoid the Skerries at night, or in thick weather, a vessel should not approach them within 25 fathoms water; and in coming from the northward, if wishing to run to the westward of them, she should keep the Start light on a S.W. ½ S. bearing, and round the Start at a distance of a quarter of a mile on its northern side, and half a mile on its southern side.

The EDDYSTONE LIGHTHOUSE, a gray granite tower 168 ft. high, bears East, northerly, 38½ miles, from the Lizard, and W. by N. ½ N., 18½ miles, from Bolt Head, near Salcombe. The light shows *two bright flashes* of 2½ seconds every half-minute, separated by an interval of 4 seconds, and followed by an eclipse of 21 seconds; it is elevated 133 ft. above high water, and visible 17 miles. At 40 ft. below it a *fixed bright* light is shown over Hand Deeps. In foggy weather an explosive signal gives a report like a *Gun*, once every 5 minutes.*

At 3½ miles N.W. ½ N. from the lighthouse, is a bed of sunken rocks, called the *Hand Deeps*, which lie nearly in the fairway of ships bound from the westward for Plymouth Sound. They consist of rocky pinnacles, and on the shoalest part there is a depth of 22 to 24 ft. at low water spring tides. The shoal has, commonly, a ground-swell on it; and with a S.W. gale and ebb tide, the sea here runs very high, so that a ship may depress (or *scend*) 5 or 6 feet.

The best mark for clearing this dangerous shoal is furnished by the Breakwater lighthouse, in one with Penlee Point, E.N.E.; this leads a long mile to the north-westward of it. When in one with Mount

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* The present lighthouse, completed in 1882, stands 100 ft. S.S.E. from the base of Smeaton's tower, the upper part of which now stands on Plymouth Hoe.

Batten in Plymouth Sound, N.E. by E., a vessel will pass a mile to the S.E. of it.

PLYMOUTH SOUND is the most capacious and secure harbour along the South coast of England. The magnificent breakwater is 1,700 yards long, and at its West end is a lighthouse, 76 ft. high, showing an *occulting* light, eclipsed for 3 seconds once in every half-minute; it is *bright* seaward, and *red* southward of N.E. ¼ E. over the anchorage within. Below is a *fixed bright* leading light, visible only in the fairway of the western entrance. A large *Bell* is tolled in fogs or snow-storms, one stroke every 15 seconds.

On the East end of the breakwater is a *Beacon*, a granite obelisk, surmounted by a staff and ball. The ball is so constructed that ten persons might find shelter within it, should they be cast away on the breakwater. Besides these there is a look-out house or signal-station on the *Hoe*, at the head of the Sound, eastward of which is the old Eddystone lighthouse, occupying the site of the former Trinity beacon.

The entrance of Plymouth Sound is distinguished on the eastern side by two remarkable large rocks, which lie upon the extremity of reefs stretching from the shore. Of these the southernmost is called the *Mewstone;* the northernmost, the *Shagstone.* The first, 194 ft. high, lies nearly half a mile S.S.W. from Wembury Point, or the S.E. point of the Sound, and has, just outside it, a smaller one, called the *Little Mewstone*, from which a shoal stretches nearly 1½ cable to the S.W. by W., and is marked by a *black buoy* in 9 fathoms, off its outer extremity.

The bearing and distance from the Great Mewstone to Rame Head are W.N.W. 4⅓ miles, and to Penlee Point N.W. by W. ¼ W. 3⅛ miles. The entrance of Plymouth Sound lies between the two latter, and it may, from a distance, be readily known, the land over Plymouth being high double land. On a near approach, Rame church will appear open to the northward of Rame Head, and the square tower of Penlee will be seen standing upon the highest part of the land over Penlee Point, and affords the more certain mark.

Reny Rocks appear like a black rock, lying 8 cables N.N.W. from the Mewstone, and at about 1 cable off shore. At 1⅜ cable W. by N. from the islet stands the *Shagstone*, a small rock, on which stands a conical *black beacon*, 21 ft. high, surmounted by a ball.

The *Tinker*, and the *Knap* and *Panther*, are the principal shoals in the lower part of the Sound, outside the breakwater, the outer one being the Tinker. This shoal is 1 cable wide, stretches nearly one-quarter of a mile East and West, and its eastern extremity lies 4¾ cables N.W. ½ W. from the Shagstone beacon; the depth on it is from 2½ to 3½ fathoms. Off the shoalest part of the western end, without the depth of 18 ft., there is a *red buoy*, and off the S.E. side is a *chequered black and white buoy*, which marks the *Eastern Channel.* With Bolt Head open to the southward of the Mewstone, or hidden behind it, you will be well to the southward of the Knap and the Tinker.

The *Knap* and *Panther* are extremities of one rocky ledge, off the West end of the breakwater, upon which there are depths of 3¼ to 4, 5, and 6 fathoms. This ledge is more than one-third of a mile in length, N.E. by E. and S.W. by W., and each end distinguished by a *red buoy*. The low *bright* light in the breakwater lighthouse, kept open, leads clear westward of these shoals.

A reef extends 2 cables S.S.E. from Penlee Point, and terminates in a sunken rock of 10 ft. water, called the *Draystone*, marked by a *chequered red and white buoy*, which lies in 5 fathoms, 2 cables from the point.

Western Channel, to the westward of the Knap and Panther, has sufficient depth for the largest ships, and is the *principal* channel to Plymouth Sound, being the only one that can be used safely by large vessels at all times of the tide. Ships coming in here for the Sound should, in the first instance, to clear the Draystone, as well as the Knap and Panther, bring the breakwater lighthouse in a line with the white tower on Mount Batten, N.E. by E. To keep to the southward of it, keep the end of Bovisand Pier in a line with or open to the southward of the beacon on the East end of the breakwater.

There is generally a good deal of sea running during the ebb tide, near the West end of the breakwater, and near this a sailing ship is very liable to miss stays in working out, by reason of a cross sea and an eddy tide. The ship should, therefore, be put about before getting too near to the West end of the work, in order to avoid the risk of missing stays and drifting upon it.

To sail in during the night, bring the Eddystone light about S.W., and steer N.E. by N., or N.E. by E., according to the wind and tide, until the water shoalens to 20 fathoms, when Penlee Point will be about 1½ mile distant; or, until you make out the breakwater light, which should be brought to bear N.E. by E. until the *bright* leading light in the lighthouse is seen, when the channel will be open; and keeping the leading light in sight, run direct for it. After rounding the breakwater, haul to the north-eastward, but do not anchor till the breakwater light has fully changed to *red*, which it will do when it bears S.W. ½ W. The water shoalens to 9 or 10 fathoms, about three-quarters of a mile from Penlee Point; this side being the safest to run in by in the night, or in thick weather. Be careful to go no nearer to the point than in 9 fathoms, as this depth is but little more than half a mile from shore. With the point W.N.W. you will be above the danger, and may then steer for Cawsand Bay, according to circumstances.

The Eastern Channel into Plymouth Sound should not be attempted at night, or by sailing vessels of any considerable draught of water, unless with a free wind, because of the numerous scattered rocks in its vicinity, and the occasional scend or depression of the sea there, with south-westerly and south-easterly winds. The mark for this channel is, to bring the beacon on the eastern end of the breakwater in one with the old Eddystone lighthouse on the Hoe, bearing N. by E. ⅜ E., which will lead between the Tinker and the Shagstone. This channel is perfectly safe, and always desirable with a leading wind and smooth water, and for this reason is much frequented during easterly winds. It is not, however, advisable to beat through this channel, unless in small vessels, in charge of persons well acquainted with the locality, for there is no anchoring ground in it.

In the centre of the fairway, however, are several rocky patches, of 4¼ and 4½ fathoms, at low water springs, the eastern extremities of which rather encroach upon this line of direction; two of these lie nearly half a mile to the southward of the breakwater, and are marked by *black and white chequered buoys;* the eastern end of the Tinker is marked by a similar *buoy;* and the shoal bank (which extends from the eastern shore and the Shagstone) by *two black buoys.* The above mark will lead up to the East end of the breakwater, leaving the *black* buoys to starboard, and the *chequered* to port. The breakwater may be rounded for the anchorage at the distance of 100 or 150 yards, leaving the Leek Bed and Duke Rock to the northward.

The Anchorage within and near the breakwater is reserved for the use of war vessels. Merchant vessels anchor in the N.E. part of the Sound, between Mount Batten breakwater and Ram's Cliff Point, the western limit being with the Hoe tower and diamond mark in line, N. by E. ¼ E. There are facilities at Plymouth for the repair of vessels and their machinery, including patent slips and dry docks, the largest 460 ft. long, with 22 ft. over the sill at high water. Coal and other supplies may be obtained here, and steam-tugs and pilots are always in readiness.

FALMOUTH HARBOUR is one of the best in England, its advantages arising from its peculiar situation, and from the influx of several rivers. The entrance is formed by the bold rocky coast of *St. Anthony Point* on the East (on which is a lighthouse showing a *revolving bright* light every 20 seconds, elevated 72 ft., and visible 14 miles), and by the headland called *Pendennis Point* on the West, distinguished by Pendennis Castle, which stands over it, on the summit of a hill. A lower *fixed bright* light is shown between S. by W. and S.W. by S. ¾ S., 37 ft. below the revolving light, and vessels by night must not lose sight of this in passing the Manacles. In foggy weather a *Bell* is sounded four times in quick succession every minute.

From St. Anthony Point to Pendennis Point the compass bearing is N.W. by W. ½ W., exactly 1 mile. St. Anthony Point bears nearly West, distant 31 miles from Rame Head. Within St. Anthony Point, on the East side, are the castle and town of *St. Mawes*, standing on the North side of St. Mawes Creek, or the entrance of the River Penkule; and within Pendennis Castle, to the N.W., stands the town of Falmouth.

On the North side of the Pendennis Peninsula is a range of docks, with the necessary graving docks and other appliances; the largest dry dock is 537 ft. long, with 22 ft. over the sills at high water springs. Coal and other supplies are plentiful here, and there is every facility for repairs. Steam-tugs and pilots are always in readiness.

In the entrance of the harbour, at one-third of a mile E. ½ S. of Pendennis Point, and 7 cables N.W. ⅛ W. from St. Anthony Point lighthouse, is *Black Rock*, which is uncovered, at spring tides, from 2¼ hours ebb to 3½ hours flood. There is a *beacon* on it (a cone with mast and ball), which sufficiently indicates its situation. At about 1 cable S.S.E. from Black Rock, is a rocky shoal of 16 to 19 ft. water; between this shoal and some rocks which lie off St. Anthony Point, is the usual entrance into the harbour.

Off the entrance of the harbour is the *Outer Anchorage*, or what may be more properly called *Falmouth Outer Road*, from St. Anthony Point toward the Manacle Rocks. Here there is good anchorage with the harbour's mouth open, equal in point of riding to Mevagizey Bay, superior to Cawsand Bay, and very little inferior to Torbay, with the wind from S.W. round to the westward, and northward, to the N.E. The best position is in 11 fathoms, sand and shells, nearly 1½ mile South of Pendennis Castle, with Budock Church, on the high land, in line with the middle of the sandy beach of Swanpool, N.W. ¾ N., and St. Anthony Point lighthouse N.E. ⅛ E., distant 14 cables. In taking this anchorage care should be taken to avoid the *Old Wall*, a rocky shoal, lying nearly 1¼ mile S. ½ E. from St. Anthony Point lighthouse. Its shallowest part is a small pinnacle rock, with no more than 25 ft. of water on it. The marks for it are the Restronguet smelting-chimney, up the creek, in line with the eastern end of the broken rocks off St. Anthony Point N. ⅛ W., and Greeb Point next North of Killygerran Head showing close East of the latter, N.E. ⅛ N. For 4 cables within the Old Wall there are depths of 8 and 9 fathoms, but between that and the point the depths are very irregular from 4 to 5 and 5½ fathoms.

A vessel from the westward, bound to Falmouth, by night should keep the Lizard lights in sight to the southward of the Beast until St. Anthony lower *fixed* light comes in sight, which is shaded over the Manacles on the bearing of S.W. by S. ¾ S., and leads one-third of a mile East of a *bell buoy* on their eastern side.

In the daytime the Beast should be kept open of Black Head; and when St. Anthony lighthouse bears N. by E. ¾ E., keep it on that bearing till Killigannoon house (among the trees) is in one with Penarrow or Mylor Point, bearing North, which will lead in through the eastern channel, and through the narrows into *Carrick Road*, where a vessel may anchor in from 12 to 18 fathoms; or proceed on until Budock Church comes over the rising ground of Trefusis Point, or a spire is in one with Falmouth Church bearing W. by S. ⅝ S., which will lead through *Cross Road*, till St. Keverne Church comes over Pendennis Point, bearing S.W. ¾ S., with which mark she may anchor in *St. Just Pool*, in from 12 to 15 fathoms, over a muddy bottom.

In hazy weather, a vessel should give St. Anthony Point a berth of 2 or 3 cables' lengths, and run in with the land of St. Mawes about a point on the starboard bow, and then steer for Penarrow Point. She should not approach the land of St. Mawes nearer than 2 cables, nor St. Mawes Bank within 9 or 8 fathoms. With the wind at East a sailing vessel will sail in free on the starboard tack, and with it at W.N.W. on the port tack.

Western Channel.—Vessels not drawing more than 18 ft. may safely pass between Black Rock and Pendennis Point, and at half-tide there is sufficient water for large vessels. By taking the centre of the channel, and steering a N.E. by N. ½ N. course, it will lead up between the buoys in the narrows; or when Black Rock beacon and the lighthouse are in one, steer for St. Mawes Castle until Killigannoon House comes on with Penarrow Point, bearing North, and proceed as before.

THE LIZARD is a bold headland, which lies 4¾ miles W. by S. ½ S. from Black Head, and 38½ miles W. ⅛ S. from the Eddystone. It may be seen 20 or 25 miles off, in from 40 to 42 fathoms of water, and may be readily known by the two lighthouses upon it. These lighthouses, each showing an *electric fixed bright* light, elevated 230 ft., and visible 21 miles, when in line, bear W. ¾ N. and E. ¾ S., 222 ft. apart. The towers, each 61 ft. high, are painted white. In foggy weather a *Siren* sounds *two* blasts in quick succession every 2 minutes, the first blast a high note, the second low.

This headland is one of the most noted among English navigators, as it is from hence that ships mostly take their departure from the English Channel; and it is also the best place for a landfall, when homeward bound, but care must be exercised in approaching, as rocks extend half a mile off. The position of the high lighthouse is lat. 49° 57′ 34″ N., long. 5° 12′ 4″ W. There is a *Signal Station* on *Beast Point*, to the eastward.

MOUNT'S BAY, the spacious bay to the N.W. of the Lizard, takes its name from *St. Michael's Mount*, which is a remarkable and picturesque isle, 262 ft. high, near the village of Marazion, 14¼ miles N.W. by N. ½ N. from the Lizard Point, and 2 miles E. by S. ¾ S. from Penzance Pier. On its summit is a church and residence, and at its foot, on the N.E. side, is a small harbour. At low water there is a dry passage to the isle from the main land.

At 4 miles N.N.W. of the Lizard, and at a small distance from shore, lies a remarkable cragged rock, *Mullion Island* or *Gull Rock;* ships bound up Channel, if opposed by an easterly or S.E. wind, run in on the North side of this rock, and here find shelter, near the shore, in 8 fathoms; but great care must be exercised to guard against a sudden shift of wind.

On the West side of the bay there is tolerable riding in *Guavas Lake*, in 3 to 8 fathoms, near Newlyn, with westerly and southerly winds; but near this place are two sunken rocks, called the *Lowlee* (marked by a *buoy*) and the *Carn Base*. The first, which has only 4 ft. over it, lies one-third of a mile from Penlee Point, with the church of St. Paul bearing W. by N. The latter also has 4 ft. over it, and lies one-third of a mile North from the former, with St. Paul's Church on with a long hedge, appearing end on, about halfway between Penlee Point and Newlyn, and bearing W. by S. Between these rocks there is a depth of 10 fathoms.

In the winter season the anchorages in Mount's Bay ought only to be resorted to as a preliminary to entering the tidal harbours of Penzance or Newlyn, or that of Mount St. Michael. Coal and other supplies can be obtained at Penzance.

In approaching the shore from the offing, between the Lizard and Land's End, the depths of water will be found to diminish gradually, and the bottom is mostly of coarse sand, interspersed with whole and broken shells.

Near the shore, between Mount's Bay and the Land's End, there are several dangerous rocks, the outermost of which is the *Rundlestone*, a small rock, about 4 yards long and 6 ft. broad, the base of which is dry at low water, and covered before half-flood. It had a fine conical stone beacon on it, but this was destroyed by the sea. From this rock the lighthouse on the Longships, hereafter noticed, bears N.W. by N. ¾ N., distant nearly 4 miles; and the *beacons* on Point Tol-Peden-Penwith N. by E., with the point distant three-quarters of a mile. The ground without the Rundlestone is clear, but there are rocks and foul ground to the eastward and northward of it; therefore a passage within it cannot be recommended to strangers. A *bell buoy* lies to the southward of it, but it frequently breaks adrift. By night Longships *red* light covers the rocks.

Wolf Rock Lighthouse bears from the Land's End, or the westernmost point of land, S.W., 8¼ miles; between it and the Rundlestone there are depths of 20 to 37 fathoms. The rock rises 11¼ ft. above low water springs, is steep on all sides, and has within half a mile of it from 20 to 30 fathoms all round. The lighthouse is a gray granite tower, 135 ft. high, and at an elevation of 110 ft. exhibits a *revolving* light every half-minute, showing alternately a *bright* and a *red* flash of equal power, visible 16 miles. A *Bell* is sounded in foggy weather, *three* times in quick succession every 15 seconds.

Longships.—About 3 miles N.W. by N. from Tol-Peden-Penwith, or the S.E. point of the Land's End, and over 1 mile W. by N. ¼ N. from the westernmost point, lie the high rocks called the *Longships*, which extend about half a mile N.W. by N. and S.E. by S. On the largest of these rocks stands a granite lighthouse, 117 ft. high, from which an *occulting* light is shown, eclipsed for 3 seconds once in every minute; the light is elevated 110 ft., and visible 16 miles. It is *bright* to westward between N.E. by N. ½ N. and S. by E. ¼ E.; to the eastward of these bearings the light appears *red*. When approaching from the northward, by keeping in the *bright* light, you will pass half a mile westward of the Brissons; and in approaching from the southward, three-quarters of a mile westward of the Rundlestone. In foggy weather, *two* explosive reports, like a *Gun*, are made every 10 minutes.

There is a passage between the Longships and the shore for ships of any draught, but it is narrow and intricate, and therefore seldom used by sailing vessels.

LAND'S END may be seen in clear weather when 25 miles off. When first seen at a distance it appears in two round hummocks, on the highest of which is the spire steeple of St. Burian, the base of which is 409 ft. above the sea; upon a nearer approach, the spire of Sennen Church will appear on the outermost point. By these objects the Land's End may be readily known; but at all times the Longships lighthouse will indicate its situation.

Cape Cornwall lies 3½ miles N.E. by N. ¾ N. from the Land's End. In the bay between, called *Whitesand Bay*, which lies about a mile to the northward of the latter, vessels may ride in from 12 to 15 fathoms, well sheltered from E.N.E. and easterly to S.S.E. winds; but the danger arising from westerly winds makes it little frequented. The South side of the bay is formed by Peddenmeandue Point, from which foul and rocky ground extends half a mile N.N.W.

The SCILLY ISLANDS consist of a great many small isles, islets, and rocks above water, surrounded by innumerable rocks and ledges, some of which appear at half-tide, others at low water, and the greater part not at all; many have 6, 5, and 4 ft. on them at low water spring tides. The channels or passages into the harbours, called *Sounds*, are dangerous, but well known to the fishermen of the islands, who act as pilots. With an easterly wind, a number of pilot-boats are on the look-out for vessels from the westward. One may be always found cruising from 10 to 20 miles S.W. of the islands.

St. Mary's, the largest and principal island of the group, has a *Lloyd's Signal Station* on it.

St. Agnes, which is also called the *Lighthouse Island*, 1 mile to the S.W. of St. Mary's, is the southernmost of the Scilly Islands, exclusive of a group of large rocks, which cannot properly be called islands. Shipwrecks have been too frequent about these islands.

The Lighthouse, standing on the most elevated ground of St. Agnes, is 74 ft. high, and, being painted white, is a useful daymark to all ships coming from the southward. The light is *bright* and *revolves* every half minute, elevated 138 ft., and visible 18 miles. To the northward it is frequently obscured by the intervening islands.

From the lighthouse the Lizard bears E. by S. ½ S., distant 45 miles; the Longships lighthouse E. ½ N., 25½ miles; and the Wolf Rock lighthouse E. by S., 21¼ miles.

The S.W. Dangers of Scilly are those called the *Bishop and Clerks*, composed of a high rock, called the *Bishop*, on which is a lighthouse, and of several ledges to the South and East. The *Bishop's Ridge*, having a race upon it, lies nearly a mile to the South of the Bishop, with the lighthouse on St. Agnes bearing E. ¾ N., 4 miles distant.

BISHOP ROCK LIGHTHOUSE is a noble granite tower, 183 ft. high, situated to the S.W. of all the dangers around the Scilly Isles, and renders the approach to them comparatively easy, as it is almost the only dangerous quarter from which to make them. The light shows *two bright flashes* every minute, separated by an interval of 4 seconds, followed by an eclipse of 48 seconds; it is elevated 143 ft., and visible 18 miles, but is obscured to the N.E. by the islands of St. Martin and St. Mary. In foggy weather an explosive report, like a *Gun*, is made once every 5 minutes.

On *Round Island*, the northern island of the group, is a white tower, 63 ft. high, showing a *revolving red* light every half-minute, elevated 180 ft., and visible 20 miles. It is also proposed to exhibit a light on Giant's Castle Head, St. Mary's.

The great importance of the Scilly Islands arises from their advantageous situation, as commanding equally the St. George's Channel and the English Channel. For this reason many ships, when the wind is favourable, in coming in from the S.W., endeavour to make the islands, in order to steer their course with greater certainty. It is also sometimes convenient for vessels to take shelter among them rather than beat about at sea in bad weather, and a strong gale at East will be frequently the means of bringing in numerous vessels. Upon making signals, a boat immediately puts off from the nearest island with pilots.

In coming from the south-westward you will descry Scilly, in clear weather, at the distance of 18 or 20 miles, and have about 60 fathoms, with gray sand, and broken shells; at that depth you may also find stony ground with some shells; but at 20 miles distance to the W.N.W., you will have sand and oaze mixed together.

The Seven Stones are a dangerous reef of rocks, which appear above water, some at half-tide, and some at low water, nearly a mile in extent North and South. The sea always breaks upon them; and, except in very thick weather, they may be seen from a considerable distance. *Pollard Rock*, on the N.W. side, lies 15 miles W. by N. ¼ N. from the Longships lighthouse, with the beacon on St. Martin's Head W. by S. ¾ S., 7 miles distant. The Telegraph Tower on St. Mary's bearing S.W. ¾ W. leads 2 miles north-westward of the Seven Stones.

The Lightvessel is moored in 39 fathoms, about 2¼ miles E. by N. ⅛ N. from Pollard Rock, and 2⅛ miles N.E. by E. ½ E. from the South Stone, with the Longships lighthouse bearing E. by S. ¾ S., distant 13 miles. The light shows *three bright flashes* in quick succession, in 24 seconds, followed by an interval of 36 seconds darkness; it is elevated 38 ft., and visible 11 miles. In foggy weather a *Siren* sounds *three* blasts in quick succession every 2 minutes, a high note between two low notes.

Vessels navigating between the Scilly Islands and Land's End should endeavour to bring the lightvessel to bear to the westward of South, when coming from the northward; and those approaching from the southward, should keep her to the westward of North. On no account should a vessel attempt to pass between the lightvessel and the dangers.

TREVOSE HEAD appears as a round hill, 232 ft. high, which first makes like an island. On it stands a white lighthouse, 87 ft. high, showing an *occulting bright* light, elevated 204 ft., and visible 20 miles; it shows *fixed* for 45 seconds, and is eclipsed 3 times during the next 15 seconds.

HARTLAND POINT, 35 miles N.E. ¾ E. from Trevose Head, is very high, and a ridge of rocks, on which the sea breaks very heavily, extends about one-third of a mile off it. The mark to clear these rocks on the West is *Sharp's Nose*, a high bluff land, nearly 8 miles to the southward, S.W. by S. ¾ S., or kept well open. The mark to clear the rocks on the North is, *Gallendy* or *Gallantry Bower*, to the West of *Clovelly*, with a tuft of trees on it, kept open, or bearing S.E.

Hartland Point, the S.W. point of the Bristol Channel, may be readily known from the connecting cliffs trending nearly at right angles to each other. It appears of a dark brown colour, and its summit resembles the ruins of a building, elevated 350 ft. above the sea, toward which it slopes abruptly to the perpendicular cliffs.

The Lighthouse on the point is a white tower, 59 ft. high, showing a *revolving* light, elevated 120 ft., and visible 17 miles; it revolves once every half-minute, showing alternately a *bright* flash twice, and a *red* flash. In foggy weather a *Siren* sounds *two* blasts in quick succession every 2 minutes, the first a high note, the second low.

Should a vessel be forced into the entrance of the *Bristol Channel*, so that she cannot lay out again, the most prudent course is to proceed, as directly as possible, for Milford Haven; but, should the weather be thick, and circumstances prevent this, she may proceed to Lundy Island, and there anchor, or take a pilot for Ilfracombe Harbour. By obstinately endeavouring to beat out of the channel, many lives and much property have been sacrificed; it being next to impossible for a sailing vessel to get to windward here, when opposed by the swell and indraught.

A vessel from the *Longships*, if bound into the Bristol Channel, with the wind from the N.E., should stretch as far to the North as she can, and to the westward of the rocks off St. Agnes Head, and then work up in the slack. With an easterly wind you may find a good stopping place for a tide, on the western side of Trevose Head, sheltered by the *Quies* or *Cow and Calf Rocks*. In the great bight northward of this, between Tintagel Head and Hartland Point, the tide is quite slack, and a vessel may gain ground against the ebb.

With the wind to the South or S.E., and a commanding breeze, you may run between the Longships and the main, or haul close round the Longships within a cable's length westward of it, and keep the English shore on board: for so soon as you bring the Longships and Brissons nearly in a line you will gain the true Channel tide. Spring tides set very rapidly in the Bristol Channel. When the wind is to the S.S.E. in the channel, the stream westward of Hartland Point is mostly found setting S.S.W.

Pilots for Bristol may be engaged at Lundy or Ilfracombe. Sailing vessels bound to Bristol, or any port well up the channel, are recommended, in general, to keep near the English shore, though without going into any of the bays, after passing between Lundy Island and Hartland Point.

LUNDY ISLAND is 2½ miles long N. by E. and S. by W., and at half a mile within its southern end is a white lighthouse, 96 ft. high, showing a *revolving bright* light once every minute, elevated 540 ft., and visible 31 miles. At 70 ft. below, a *fixed bright* light is shown between N. by W. and S.W., visible 28 miles. In foggy weather, an explosive *Rocket* is discharged every 10 minutes, on the West side of the island. Vessels bound up the channel, or to the anchorage on the eastern side of the island, are recommended to pass to the southward of the island, all circumstances being favourable. There is a *Lloyd's Signal Station* on Lundy.

MILFORD HAVEN has been generally considered as the most capacious, the most commodious, and the most secure harbour in the British Islands. It was usual some years ago to state that "there was no sort of danger in its entrance that could not be avoided without a pilot," an assertion based on the supposed accuracy of the elaborate Admiralty Survey; but an accident led to a closer examination, which showed that the entrance is bestrewed with dangers to vessels of the largest class at dead low water.

St. Ann's Head is a bold promontory, advancing from a background of nearly table land, with a large black rock at its extremity, always appearing above water. Irregular depths of 3 to 5 fathoms extend half a mile off the head, in a S.W. ½ W. direction from the high lighthouse, and at half a mile S.W. by S. ½ S. from the low light is a 4½-fathoms patch. This point lies N.E. by N., 96 miles, from Cape Cornwall; N. by W., 47 miles, from Hartland Point; and N. by W. ¼ W., 34¼ miles, from the North end of Lundy Island.

On St. Ann's Head are two white lighthouses, 203 yards apart, which, when in line bearing N.N.W., lead up to and over Mid-Channel Rock. Each lighthouse shows a *fixed bright* light, visible 18 to 20 miles, and the high light is *red* between East and S.E., over Chapel and Harbour Rocks. In foggy weather a *Siren* gives one blast every 3 minutes.

To enter the haven with a fair wind, at any time before half-ebb, give the southern side of St. Ann's Head a berth of one-quarter of a mile, in a depth of 12 or 11 fathoms; when past the shoals on the N.E. side of Mill Bay, steer so as to bring the lower light to bear about W. ½ S., astern, and then running E. ½ N., about 1¾ mile, the depths will decrease to 8 and 7 fathoms, and you will be in the middle of the harbour.

The two *fixed bright* lights on *Great Castle Head*, facing the entrance, when in line bearing N.E. by E. ¼ E., lead in the best water between St. Ann's Head and Mid-Channel Rocks. This channel is preferable to that eastward of the latter dangers, being wider and deeper.

In the entrance to the haven the first danger met with was only discovered in the latter part of 1851—a very singular circumstance, considering that the whole of the coast was supposed to have been carefully and completely surveyed. It is a small patch called *Lewis* or *Mid-Channel Rock*, 1½ cable long, W.N.W. and E.S.E., and having only 16 ft. least water near its centre, at three-quarters of a mile S. by E. ¾ E. from the low light; it lies just westward of the line of the two lighthouses at St. Ann's in one. A *red buoy* is placed off the N.W. side of the shoal. Besides this rock there is another, discovered at the same period, called *Sheep Rock*, a small patch of 3½ fathoms, lying half a mile W. ¼ S. from Sheep Island. Both patches have 5 to 8 fathoms water around them.

Chapel Rocks, half a mile W. by N. from Rat Island, have 12 ft. water over them at low spring ebbs, and are marked by two *buoys*, a *red* buoy off their N.W. side, and a *red* and *white striped* buoy off their S.W. side. *Harbour* or *Thorn Rock*, having 6 ft. least water over it, lies 3 cables N.W. by W. ¾ W. from Thorn or West Angle Islet, and is marked by a *red buoy* to the westward of it. The channel between these shoals and the western shore is nearly a mile in breadth, and by night St. Ann's high light shows *red* over them.

The safe course in is N.E. by E. ¼ E., with the lights on Great Castle Head in one, until you open Dale Road, in the N.W. corner of the Haven, where you may come-to, as convenient, so soon as Dale Town comes open. At 1½ cable N.E. of Dale Point, 4 fathoms will be found, decreasing gradually to the W.N.W. The best channel up to Milford, and that commonly used, is to the southward of the *Stack Rock*. Upon the South side, hereabout, is excellent ground, in from 8 to 14 fathoms, where ships may lie landlocked from all winds.

At 1 mile S.S.E. from the Stack lies the entrance of *Angle* or *Nangle Bay*, nearly all dry at low water, but in which the ground is clear and good. In this place vessels, having lost their cables and anchors, may run aground on soft oaze; but should keep nearly in mid-channel between the outer points.

The most convenient anchorage for large ships is in *Hubberston* or *Man-of-War Road*, at 4 miles to the E.S.E. of Dale Point. In sailing for it, keep in mid-channel until the town of Milford bears about N.E. by E., when you may anchor in 10 or 12 fathoms. Pilots are usually cruising off the entrance of the haven, and the services of a steam-tug can be had if required. Coal can be supplied in any quantity to steamers requiring it, the stores and shipping pier being at *Newton Noyes*, 1 mile S.E. of the town.

Milford Dock is approached by a dredged channel, having a depth of 12½ ft. at low water springs, and ordinary springs rise 25 feet. The entrance lock is 549 ft. long, with a depth of 26 ft. over the sill at high water springs. The dock is spacious and capable of accommodating vessels of large size, as its depth is 34 ft., but hitherto it has mainly been used by fishing vessels. Supplies of various kinds can be obtained here, and there is a fine dry dock 600 ft. long. *Pembroke Dockyard* lies 3 miles above Milford.

The SMALLS consist of a cluster of low bare rocks, about 4 cables in extent N.E. by E. and S.W. by W., and some are never entirely covered. Upon the largest and westernmost of them stands the *lighthouse*, a granite tower, 141 ft. high, painted in red and white bands, showing an *occulting* light, elevated 125 ft., and visible 17 miles; the light is *fixed* for 54 seconds, and is eclipsed *twice* during the next 6 seconds. It shows *bright* seaward, but is *red* over the Hats and Barrels Rocks, between E. ½ S. and S.E. ¾ E. In foggy weather, an explosive report, like a *Gun*, is made once every 7½ minutes.

Several detached rocks, lying at the distance, more or less, of one-quarter of a mile from the main group, must be carefully avoided.

Passage between the Smalls and Hats.—When the Hats are seen to break, this is a good and safe channel, although not more than 1¾ mile wide. If the South Bishop, distinguished by its lighthouse, can be made out, this islet, just open of St. David's Head, will clear all.

To pass northward of the Smalls, Hats, and Barrels, care must be taken to give the Smalls a sufficient berth to clear the N.E. rock, the transit of which is passed when the lighthouse bears S.W. by W. When the land is distinguishable, an excellent clearing mark is, the N.E. end of Grassholm on with the S.W. end of Skomer; this will lead about three-quarters of a mile from the Hats, and 1¼ mile from the Barrels.

To clear the Smalls and Barrels, to the southward, the Smalls ought not to be approached within 1 mile, on coming from the westward, until the lighthouse is brought to bear North, in order to avoid the S.W. rock, as the soundings are extremely irregular, varying at that distance from 40 to 25 fathoms, generally gravel and broken shells, so that no dependence can be placed on the lead. At night, the Smalls *red* light must not be opened, nor St. Ann's lights brought to the southward of E.S.E.; these bearings will give the Barrels a berth of about 1 mile. Observe well that the moment St. Ann's lights are unmasked to the southward of Skokham, a vessel is nearly in the line of direction of the shoals.

Vessels bound for Milford Haven, &c., from the S.W. of Ireland, are recommended to make Grassholm, frequently the first land seen, by day, or the Smalls lighthouse by night. Should there be a long flood to run, it will be best, particularly with the wind to the southward, to pass well South of the light, or to try and make St. Ann's lights upon a bearing of E. by S. ½ S., passing outside Skokham: but on an ebb tide, opposite precautions may be taken; and having passed to the northward of the Smalls, keep St. Ann's lights open between Skomer and Skokham, bearing about S.E., which will lead between them.

ST. GEORGE'S CHANNEL.—To give extended descriptions of this important navigation would swell this work far beyond its proper limits. On pages 467—474 are given some general instructions for sailing up and down this channel, which must suffice. One especial point requires every attention, and that is the set of the tides. In pages 288—289, are given the general features of these currents, which, being neglected, have led to several deplorable accidents on the banks off the S.E. coast of Ireland. It is therefore most earnestly recommended to the sailor to pay every attention to this important subject.

On the eastern side of the channel the indraught to Cardigan and Carnarvon Bays is in some degree deprived of danger by the establishment of the lightvessels, which will warn a ship from passing too far to the eastward, and thus getting embayed on this iron-bound shore with its dangerous shoals.

The Refuge Harbour at *Holyhead* has assumed an important position in the navigation of this channel, and will afford shelter from bad weather for a large portion of the compass. *St. Tudwall Roads*, in the northern part of Cardigan Bay, will also be found a valuable place of shelter, now that it is so well lighted.

THE SOUTH COAST OF IRELAND.—As ships bound across the North Atlantic may be driven to seek shelter on the Irish coast, a few brief notices of the principal places on the southern coast follow. Complete descriptions of the whole coasts of Ireland are given in the Sailing Directories, accompanying the charts.

CARNSORE POINT lies 125½ miles N. ¾ E. from Cape Cornwall, and 37½ miles N.N.W. from the Smalls lighthouse. A *Lifeboat* is stationed here. At 6 miles E. ⅓ S. from Carnsore Point, is the remarkable rock called the *Tuskar*, about 15 ft. above the sea at high water, the bearing and distance of which from the Longships lighthouse, off the Land's End of England, are N. by E. ¼ E., 130 miles; and from the Smalls lighthouse, N. by W. ⅛ W., 35 miles.

The Tuskar Lighthouse is a white tower 113 ft. high, showing a *revolving* light every minute, *bright* and *red* alternately, elevated 108 ft., and visible 19 miles. In foggy weather, an explosive report, like a *Gun*, is made once every 5 minutes.

At 2 cables to North, South, and West of the lighthouse are some rocky heads, and at two-thirds of a mile S.W. of it is *South Rock*, of 7 ft., at three-quarters of a mile S.S.W. of which a *red buoy* is moored in 25 fathoms; to avoid these, be careful to keep sufficiently without the rock on that side. Nearly midway between the Tuskar and the main is the long, narrow bank, called the *Bailies' Prong*, the ripple on the South end of which bears W. ¾ S. from the Tuskar, and from Carnsore Point E.S.E., about 2½ miles; the bank thence extends to the shoal off Greenore Point, and has least depths of 5¼ to 7 fathoms, with 8 and 10 fathoms near each end. To pass East of it, keep nearer to the Tuskar than the main.

The Coningbeg or Barrels Rocks, two small rocks appearing about half-ebb, lie 1½ mile S.W. by W. from Carnsore Point, and a *black buoy* lies near their southern side. A *lightvessel* lies in 27 fathoms, 2¼ miles S.W. by S. ¼ S. from them; the light is visible 10 miles, and shows *two quick bright flashes* in 8 seconds, followed by 22 seconds darkness. A *Gong* is sounded in foggy weather.

Saltees Lightvessel lies in 29 fathoms, with the Great Saltee bearing N.E. ½ N., distant 4¼ miles; the Hook Lighthouse of Waterford Harbour, N.W. ¼ N., 11½ miles; and the Tuskar Lighthouse, E. ⅜ N., 19½ miles, Barrels Rocks lightvessel lying about midway between. The light shows *three bright flashes* in 23 seconds, followed by 37 seconds darkness, elevated 38 ft., and visible 10 miles. In foggy weather a *Siren* sounds *two* blasts of 2½ seconds, separated by an interval of 25 seconds, and followed by 90 seconds silence. Between the lightvessel and Great Saltee Island lie Coningbeg and Coningmore Rocks, the latter always visible.

WATERFORD HARBOUR is formed by the estuary of the Rivers Suir and Barrow. From the Longships lighthouse, off the Land's End of England, the Hook Point of Waterford bears N. ⅛ E., distant 132 miles; from the North end of Lundy Island, N.W. ¾ N., 103 miles; from St. Ann's lights, Milford Haven, N.W. ¼ W., 72 miles; and from the Smalls lighthouse, N.W. ⅛ N., 53 miles.

Upon *Hook Point* is a tower, 115 ft. high, painted red and white in horizontal bands, which exhibits a *fixed bright* light, elevated 152 ft. above high water, and visible 17 miles. In foggy weather a *Gun* is fired once every 10 minutes.

The entrance of the harbour, between Hook Point on the East, and Red Head on the West, is 2¾ miles wide. At 3 miles within these points, on the western side, is the remarkable promontory called *Credan Head*, the extremity of which bears N. ¾ E., 3¼ miles, from Hook Point.

The little harbour of *Dunmore*, on the West side of the entrance, affords a secure anchorage with westerly gales, as well as from the prodigious sea which rolls along the southern coast, but it is not calculated for a harbour of refuge, from its space being very confined, and its want of depth, there being only one spot within the pierhead with more than 14 ft., and 9 to 12 ft. is the ordinary depth at low water.

In coming in from sea for Waterford Harbour, you will descry the remarkable inland mountain called the *Slievnaman*, which should be brought to bear N.E. by N., as it will, with that bearing, lead in sight of Hook Tower; whence you may round Hook Point, which should not be approached nearer than to the distance of 3 cables, as the tide sets round it very irregularly.

With the entrance open, the course towards Duncannon Fort will be N.E. by N. ¾ N., which will lead past Credan Head, at the distance of 3½ cables; at night *two lights* on the Fort are in line on this bearing, elevated one above the other. These kept open of Credan Head, and bearing N.E. by N. ¾ N., lead directly up the harbour, and over the bar. The *Bar*, with 2½ fathoms on it at low water, is marked by *three buoys*, 1¼ mile above Credan Head. After crossing the bar, with the Duncannon lights in one, keep them so, and then bearing to the West pass the fort at the distance of about 1 cable's length, keeping the lead going, and then steer for Ballyhack church, keeping along the eastern shore, in depths of 6 to 9 fathoms. When the Pile Lighthouse, near Passage, comes on with the town of that name, you may steer upward in mid-channel, keeping the light open on the port bow, and while passing it, giving it a berth of half a cable. A vessel will thus pass through the best part of the channel leading to the Passage anchorage, and can bring up in safety.

The city of *Waterford* is 7½ miles above Passage, or 15 miles by the river from Hook Point, and vessels drawing 20 ft. may lie afloat off the quays.

Ballycottin Bay, on the North side of the Ballycottin Isles, has been recommended as a place of safe resort in westerly winds. The only disadvantage of this anchorage is, that when the wind sets in from S.E. to East (which wind, however, *very seldom* blows) it is necessary for vessels to put to sea as quickly as possible. The prevailing winds on this coast are westerly throughout the year; therefore this anchorage is safe and convenient with the wind from S.W. to N.N.E. round by North. Vessels taking shelter from a westerly gale, should anchor with the coastguard houses bearing W. ¾ S. to S.W. by S., and the lighthouse on the outer island S. by E. to S.S.W., distant one-half to three-quarters of a mile, in 4 to 7 fathoms at low water. The bottom is smooth and even, of fine sand and clay, perfectly clean, and the holding ground good. The outer island, on which stands the lighthouse, is high, with a bold, rocky coast, steep-to, with deep water, and no dangers; so that a vessel, in taking the bay from the westward, may round the island close-to, and find herself suddenly in smooth water. The *lighthouse* is a stone tower, 50 ft. high, with a central black band, showing a *flashing bright* light, one flash every 10 seconds, elevated 195 ft., and visible 18 miles. A *Bell* is sounded in foggy weather.

QUEENSTOWN or CORK HARBOUR.—The entrance of this excellent harbour lies 141 miles N.N.W. from the Longships lighthouse, off the Land's End of England; and from St. Ann's Point, Milford Haven, 113 miles N.W. by W. ⅞ W. In coming up for it from the southward, bring Knockmeldown Hill N.E. by E., and keep it thus until you see the Old Head of Kinsale, which is a remarkable bluff headland, with a lighthouse upon it. From this head the entrance of Cork Harbour bears E. by N. ¾ N., 15 miles.

When off the harbour, Roche's Tower and lighthouse are remarkable on the point upon the eastern side. Off the South side of this point are two rocks, called the *Cow and Calf*, otherwise the *Stags*, which dry at low water. Outside the entrance, which is three-quarters of a mile wide, the ground is clean; and, with a northerly wind, ships may lie here, in from 7 to 10 fathoms, awaiting the daylight or a flood tide. With a leading wind, sailing ships may enter at any time of the day, if proper attention be paid to the marks for the dangers.

The Lighthouse on Roche Point exhibits an *occulting* light, visible for 15 seconds, and eclipsed for 5 seconds, alternately. The tower is white, 49 ft. high, and the *bright* light, which is shown at 98 ft. above the level of high water, may be seen at 10 miles off; between S.E. ½ E. and the land, and between North and the land, the light shows *red* over the rocks.

At the base of the tower a *fixed bright* light is shown, 38 ft. below the main light, to mark the position of *Daunt's Rock*, 4½ miles to the S.W. The light is shown between S.W. by W. and S.W. ½ S. In approaching Cork Harbour, therefore, keep eastward of the limits of the *fixed* light until the rock be passed.

A *Bell* is sounded once every half-minute during thick or foggy weather.

Daunt's Rock Lightvessel lies in 16 fathoms, 1½ mile S.E. ½ S. from the rock, and shows a *fixed red* light, elevated 39 ft., and visible 10 miles. In foggy weather a *Gun* is fired at alternate intervals of 5 and 10 minutes. A *buoy* is moored off the N.E. side of the rock, but it is often washed away in heavy weather.

Roche Point is bold; so also is *Dog's Nose*, a high point, 1½ mile farther in, on the same side. Upon the latter, there are some remarkable white walls on the face of the cliff, to the southward of the fort.

From the entrance of the harbour to the Narrows, in the upper part of it, and through them to the anchorage of Queenstown, the channel is marked by a double series of *buoys*, *red* on the western side, and *black* on the eastern. Besides these there are two buoys on *Harbour Rock*, and two on *Turbot Bank*.

On entering the harbour, the channel eastward of Harbour Rock and Turbot Bank is generally preferred, and a vessel may, at any time, be worked in or out. On coming in, therefore, endeavour to pass between Roche Point and Harbour Rock, or between Harbour Rock and Turbot Bank. The first route may be easily effected by keeping Cuskinny House wholly shut in with the point at Dog's Nose; this mark also leads to the eastward of Turbot Bank. The depths in the channel are 5, 6, and 7 fathoms. To pass between Harbour Rock and Turbot Bank, keep the white house in Ringabella Bay twice its own apparent breadth open to the southward of Beaulna Cove Point.

Having arrived within or to the northward of the rocks, which will be when a round stone martello tower, on the heights near Ringaskiddy (westward of Spike Island), appears four times its own breadth open to the northward of the lowest part of the declining land under Fort Camden; thence steer for the middle of Spike Island, keeping as nearly midway as possible between Forts Carlisle and Camden, until two remarkable houses, inland, to the northward of Cuskinny House, and eastward of the old barracks, appear, the northern house between Cuskinny House and the southern house, three-fourths nearer to the latter than the former. This mark will lead up between the shoals towards Queenstown.

Continue running upon the mark last given, until two whitewashed marks in the upper and lower walls of the old fort or hospital appear in one, and when Ballybrickan House comes nearly into contact with the S.W. angle of the buildings on Haulbowline Island, you should haul suddenly to the westward, steering N.W. by W. toward a large storehouse on the upper quay at Queenstown, for about 2 cables' lengths, and then W.N.W. parallel to the beach of Queenstown, until Roche's lighthouse shuts in with the eastern end of Spike Island. The last mark is the best for anchoring, and here you will have from 4 to 9 fathoms of water.

The *Outer Road*, or anchorage of Cork Harbour, is between Fort Camden and Outer Spit *buoy*. You proceed up to it with Queenstown church just shut in with the eastern angle of the citadel on Spike Island, and may take a station at pleasure in from 12 to 7 fathoms. Merchant vessels may ride off Queenstown, in smoother water and less tide; they may also anchor farther up the harbour, off Passage, and ride anywhere between the first houses and Marino Point.

Those working into or out of Cork Harbour should be aware that the tide sets, in the first instance, into the bight formed between Dog's Nose and Roche Point, and then obliquely across to Cross Haven, whence it is again warped into a N.E. direction, which produces corresponding counter-tides and eddies along both shores. The tide of ebb has a directly opposite tendency.

There is a Government Dockyard on *Haulbowline Island*, opposite Queenstown, and facilities for repairing vessels are found at the docks at Monkstown and Passage. The city of *Cork* is 5 miles above Passage, and can be reached by vessels of 1,500 tons, which lie afloat alongside. Supplies of various kinds, including coal, can be obtained here and at Queenstown.

KINSALE.—From Poor Head, which lies 3 miles S.E. by E. from Roche Point, the Old Head of Kinsale bears W. by S. ½ S., 17 miles. Two white-washed towers stand on the cape, and between them are the black ruins of Baron de Courcy's Castle. The southern tower is round, the northern square; the southern was formerly the lighthouse.

Old Head Lighthouse is erected on the rocky point at the southern end of the *Old Head of Kinsale*, distant half a mile S.S.W. from the old lighthouse tower. The light is *fixed bright*, elevated 236 ft., and visible 21 miles, illuminating an arc seaward, from N.E. ½ N. to W. ½ N. The tower is circular, 100 ft. in height, and is painted white with two red belts. In foggy weather, two *Guns* are fired in quick succession every 10 minutes.

On the arc limited by a line across the entrance of Courtmacsherry Bay, between a line drawn from the lighthouse to the Seven Heads and another line drawn to Horse Rock, the light is *red;* farther within the bay, northward of that line, it is of the natural colour. Vessels, unless going to Courtmacsherry Harbour, should not pass into the bay within the limits of the *red* light.*

In order to fall in with the Old Head, when approaching from the offing, bring and keep Knockmeldown Hill about N.E. by E. This hill lies inland to the northward of Youghal.

Kinsale Harbour, though narrow at the entrance and all the way up to the town, is very safe, and capable of receiving vessels of considerable size. The entrance, 4½ cables wide, is formed by *Hangman* and *Prehaun Points* on the East, and *Strookaun* and *Money Points* on the West; and it lies 4½ miles N.E. ¾ N. from the pitch of the Old Head. After rounding *Breem Rock*, lying under the eastern side of Old Head, with 7 fathoms close to it, steer for the harbour's mouth, by keeping the whole of *Charles Fort*, an extensive castellated building at a mile within the harbour's mouth, open to the westward of Hangman Point, and not bringing that fort within its own apparent breadth of Money Point, on the port side; having reached well within the former point, keep as near mid-channel as possible, and anchor to obtain a pilot. The anchorage of Upper Cove is the one generally resorted to, and it affords good shelter, even with the wind directly in. This place is a little within or to the N.W. of Charles Fort, and about 1½ cable from shore. There is, however, water enough for large vessels close up to the town of *Kinsale*, the channel to which lies along the eastern shore; but it is very narrow and circuitous, and requires the assistance of a pilot. The wind between S.S.W. and E.S.E. is a free wind in, and from W.N.W. to N.E. a fair one out.

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* SIGNAL STATIONS.—There is a Lloyd's Signal Station on the Old Head of Kinsale, and others are maintained on Brow Head and Tory Island.

There is a bar of coarse sand a little to the southward of Charles Fort, having 12 to 18 ft. over it at low water spring tides. When the body of Charles Fort bears E. by N. you will be within or to the northward of it, and drop thence almost immediately into 5 and 6 fathoms.

The dangers on going into Kinsale Harbour are, *Farmer Ledge* to port, and *Bulman Rock* on the starboard side. The Farmer lies close to the western shore, and is uncovered at three-quarters ebb. The Bulman lies above 2 cables S.W. by S. from Hangman Point, and has only 3 ft. over it at low water, and sometimes dries at very low tides. A *black buoy* is moored to the S.W. of it. By keeping Charles Fort wholly open to the westward of Prehaun Point, you will pass considerably to the westward of the Bulman; and by not bringing that fort within its own apparent breadth of Money Point, you will avoid the Farmer.

On Charles Fort a *fixed bright* light is shown, elevated 98 ft., and visible 14 miles; it is open to the harbour, on a N.E. by N. ½ N. bearing, but when running for the harbour in a very dark night, some caution is necessary, as this light and that on Old Head are the only guidance, and it will be prudent to keep an offing until daylight, or till a pilot can be obtained.

GALLEY HEAD LIGHTHOUSE, 16 miles W. ¾ N. from Kinsale Old Head, is a white tower 69 ft. high, showing a *group-flashing bright* light, elevated 174 ft. above high water, and visible 19 miles; it exhibits 6 or 7 successive flashes in 16 seconds, followed by 44 seconds darkness.

Cape Clear, the southernmost promontory of Ireland, upon a high and precipitous island of the same name, lies 167 miles N.W. ½ N. from the Longships lighthouse, off the Land's End of England; and about 3 miles eastward from the eastern part of this island lies the entrance to the harbour of Baltimore.

FASTNET ROCK, small, steep, and conspicuous, 93 ft. high, lies nearly 3¾ miles W. by S. from Cape Clear, the depth between being from 12 to 35 fathoms, the least depth being near to the rock. The *lighthouse* on it is a white tower 86 ft. high, with a broad red central belt. The light is *revolving bright*, visible once every minute, elevated 148 ft., and visible 18 miles; but it is not entirely obscured within short distances. In foggy weather, an explosive report, similar to a *Gun*, is made once every 5 minutes.

Between Cape Clear and the River Shannon, the land, on advancing to the North, increases in height, and is very irregular and broken; but the southern part of the coast is seldom wholly free from fog and haze during the summer months, and is generally annoyed by powerful gales and a turbulent sea during the winter season.

Long Island Sound, which lies within Long Island, to the S.W. of Skull Harbour, is well sheltered, of easy access, and capable of receiving large ships, which enter at either end of the island, and anchor anywhere, the ground being good. The only thing to be avoided is a spit of sand, which extends northward from the shore, at about a mile within the East end of the island, and more than halfway over the channel.

In the anchorages the depth varies from 2 to 7 fathoms, and the ground is everywhere a soft cohesive mud. The chief passages are, one from the S.W. between Goat Isle and Turf Isle, or Black Rock to the westward of it, called *Man-of-War Sound;* one between Goat Isle and Long Island; and one between Long Island and Castle Island on the East. Either of these passages may be safely taken without a pilot, through water sufficient for a ship of heavy draught. When entering by the S.W. passage, you have merely to keep in mid-channel all the way through, as well as from thence to the anchorage.

Crookhaven is a small but important harbour, lying 7½ miles N.W. of Cape Clear. It is only 2 miles in extent, East and West, by one-third of a mile in breadth. Its entrance lies between *Alderman Rock*, on the South side, and a peninsula called *Rock Island*, on the North. Although narrow, the harbour is well sheltered and commodious for vessels bound to the eastward; the ground is good, and the water, more than halfway up, sufficiently deep for large ships. This is a very convenient place for vessels drawing 14 ft., during bad weather or easterly gales, against which it affords the most ample shelter. Vessels in distress, or having lost their anchors, may boldly run in till they take the ground, the bottom consisting of remarkably soft mud. A pilot will come off on the usual signal being made.

Rock Island Lighthouse, on the northern side of the entrance, is a white tower, 45 ft. high, showing a *fixed* light, elevated 67 feet. The light is *bright*, but appears *red* over Alderman Rock and toward Streek Head, or when bearing between N.W. by W. and N. ¼ E. In anchoring by night, therefore, keep northward of the *red* light.

Having fairly opened the harbour, run directly in, keeping in mid-channel. The ruined signal-tower on Brow Head, three times its own apparent breadth open to the northward of O'Driscoll's House, a remarkable white one, entirely isolated, bearing about West, will lead to the northward of Alderman Rock, and into the fairway.

The opening of Crookhaven cannot be made out until you are very near the Alderman; to make it, therefore, steer in due North from Fastnet

Rock, keeping that rock South, as near as may be, until Mizen Peak comes in one with Alderman Head. In proceeding thus, you cannot be deceived because, at the same time, or nearly so, Mount Gabriel will appear in one with Leamcon signal-tower and castle to the N.E., and Brow Head, with its signal-tower, will appear to close in with Streek Head, to the westward. The harbour will now begin to unfold itself; the revenue officers' houses on the northern shore will first be seen, and, ultimately, Coghlan's Tower, which stands on the South shore, a mile within Alderman Rocks.

A sailing vessel cannot enter Crookhaven unless the wind is southward and eastward of S.S.W. by compass, or to the eastward and northward of N. by W.; but when the wind happens to be foul for Crookhaven, it will prove fair for Long Island Sound. You may anchor, with westerly and northerly winds, at a mile N.E. from Alderman Rock, in very good ground, but great circumspection must be taken as to southerly winds.

BANTRY BAY, to the northward of Dunmanus Bay, is large, safe, and commodious for ships of any size. The stream of tide is scarcely sensible in any part of it; the water is sufficiently deep, almost close to both the shores; and there are no rocks or shoals in the way, but such as may be easily avoided, even in the night. Ships may stop anywhere in the middle of the bay; or, in most parts, near to either side. The bay extends nearly in the same direction as that of Dunmanus, being 18 miles in length, and from 2 to 3 miles broad. Its entrance, between Sheep Head and the South point of Bear Island, is 4 miles wide. At 2 cables off the latter point is a rock of 18 feet. The depth of water throughout the bay varies from 10 to 31 fathoms, and the ground is of the most tenacious description. It is, however, much exposed to westerly winds; but even when these prevail, the harbours of *Bearhaven*, *Bantry*, and *Glengariff*, may be resorted to with great convenience, and even without a pilot.

Bearhaven is an excellent harbour, spacious, and well sheltered from all winds, in a country abounding with many necessary refreshments; the ground is everywhere good, and easy of access. Its proximity to the sea, and situation on the coast, render it an excellent rendezvous for a fleet.

Roancarrig Island Lighthouse will materially assist the navigation of Bantry Bay, and more particularly that of the eastern entrance to Bearhaven, off which it stands. It is a white tower, 62 ft. high, with a red belt round it, showing a *fixed bright* light, elevated 55 ft., and visible 12 miles, between E. ⅜ S. and N.W. by W. ½ W.

The haven has two entrances, one at each end of Bear Island. The western entrance is the most direct and convenient for ships from the westward or southward; but the other is the safer for strangers. You may anchor anywhere off the North side of the island, in from 5 to 11 fathoms; but the best place is off Ballynakilla; and ships waiting for a wind only will find the West end of the haven most convenient.

Bull Rock Lighthouse.—Within 3 miles of *Dursey Head* lie several conspicuous detached rocks, with deep water around them. On the outer one, named the Bull, stands a white tower 49 ft. high, showing a *revolving bright* light, once every 15 seconds, elevated 271 ft., and visible 23 miles. The light is obscured to the N.E., between N.E. by N. ⅛ N.

and N.E. by E. ¾ E. In foggy weather an explosive signal gives *two* reports like a *Gun*, in quick succession, every 15 minutes.

Valentia.—*Brea* or *Bray Head*, 7½ miles N.E. by E. ¼ E. from Skelligs Rocks lighthouse, is the S.W. extremity of Valentia Island, which lies on the South side just within the entrance of Dingle Bay; the island thence extends 6 miles East, and forms the harbour of the same name, which is capable of receiving the largest ships. It affords excellent shelter against all winds, with good holding ground in 6 and 7 fathoms at low water springs.

If bound into this place steer for Doulus Head, giving the northern side of Valentia a berth of about a mile or more, until the remains of Cromwell's Fort, on which a light is established, bear S. by E., which will then be in one with the square tower of the church standing on a cliff of Valentia Island, considerably above the water's edge, and close to which stands the parsonage house, now in ruins. This mark leads to the entrance of the harbour. When passing Cromwell's Fort, two beacons on the southern shore, kept in line bearing S.E. by S. ¾ S., lead between the rocks extending off Cromwell Point and those off Beginnis.

THE COAST OF FRANCE.—In the upper part of the English Channel, the coast of France is a part to be avoided by passing ships. Upon it all the power of the tides and waves which traverse the Channel from West to East seems to be expended. Its shores are the depository of all the matter washed and worn off from the shores to the westward, and the light drifting sand, of which they are composed, chokes up all its harbours, and bar access to any shelter when required for a ship in distress. All this is explained in our English Channel Directory; and in pages 285-286, *ante*, there are some remarks upon the Tidal Streams, which are very peculiar here, and require very much attention.

Ambleteuse Road, between Boulogne and Cape Grisnez, affords some shelter from gales between N.E. and South round by the East; but the sea is very heavy, especially when strong winds oppose the current; and moreover the tidal streams are at times very strong, so that the ship may become tide-rode in a very ugly position. *Boulogne* and *Dieppe Harbours* are difficult to enter on account of the thwart current.

The *Bay of the Seine* is very dangerous, being open to all winds from N.W. to N.E., and the tides are very strong, so that ships embayed here with those winds are in great danger.

There is some shelter inside the banks extending North and South of *Marcouf*, but the tides are so strong that they alone will embarrass, and the formidable Race of Barfleur, which runs around Cape Barfleur so turbulently, is much to be dreaded in N.E. gales.

CHERBOURG, with its majestic Digue, affords excellent shelter, and ample descriptions and directions are given in our English Channel Directions. The following are a few extracts:—

Cherbourg Road is comprised in the space between the Pointe de Querqueville and Pelée Island, lying E.S.E. and W.N.W., 3¾ miles apart.

Its southern limits are the shores of the two great bays, that of Sainte Anne to the West, and that of Cherbourg to the East, divided by Pointe du Homet. It is sheltered on the North side by a magnificent artificial breakwater, *La Digue*, built in 6 and 7 fathoms of water, and on the East and West by the new breakwaters connecting Pelée Island and Fort Chavagnac with the coast.

The principal anchorages for large vessels and men-of-war are the Great Road, and the western anchorage; for smaller vessels, that called the Little Road, and the anchorage between the Pelée Island Bank and the eastern branch of the Digue.

The Bay of Sainte Anne does not offer many good spots for anchoring; the bottom is uneven, and the holding ground bad. And besides, till the breakwater connecting Fort Chavagnac with Point Querqueville is completed, vessels are in great danger if caught here by gales between N.E. and N.W., which send a bad sea into it.

The *Great Road* (Grande Rade) is limited to the East and N.E. by the Pelée Island Bank, and extends to the West as far as the North of the Church at Cherbourg. In the North part, the bottom is, in general, of schistose rock in a state of decomposition, and the holding is good, but there are some spots of bare and cutting rocks. The current of the flood begins half an hour after low water by the shore, and ends three-quarters of an hour after high water in the military port. Its greatest rate is 2 miles, and of the ebb 1¼ mile an hour.

The *Western Anchorage*, lying to the South, and near to the West end of the Digue, is a fine bottom of sand and broken shells, four-fifths of a mile in extent, and with 6 and 7 fathoms water. It is bounded on the South by the rocky bottom, which, running from the Great Road, extends to the S.W. of the West end of the Digue. The current of the flood begins here nearly an hour after low water by the shore, and finishes an hour after high water at the military port.

The *Little Road* (Petite Rade) is to the South of the Great Road, in the part which is sheltered from West winds, and the sea occasioned by them, by Fort du Homet and the military port. In this anchorage, which is of good holding ground, the pilots place those vessels waiting for the tide to enter the commercial port. Strong winds from S.W. to S.E. are troublesome in this anchorage, as vessels are liable to drive and be carried on the rocky bottom of the Great Road, or even on to the Digue.

The anchorage to the South of the eastern branch of the Digue, which is used by vessels seeking shelter, lies between the Digue and the northern slope of the Pelée Island Bank, and extends from the Central Fort, where it is a quarter of a mile wide, to nearly the East end of the Digue, at which part it is narrowed to 1½ cable in width. It is a sandy bottom, in some parts rather muddy, the depths varying from 26 to 32 feet. Vessels are here sheltered from N.W. to N.E. round by the North.

Western Entrance to Cherbourg Roads.—Large vessels can approach the Roads by the passes at each end of the Digue, the principal of which is the West, lying between it and Chavagnac Fort. You will run precisely in mid-channel, by keeping the small light-tower (with a *red* light) on the end of the eastern jetty of the Port du Commerce clear, but seen a very little distance West, that is, to the right of the battery of the Fort du Homet.

There is no difficulty in entering with a leading wind, but large sailing ships beating in must give Chavagnac Fort a berth, and take care of La Tenarde Shoal, off Fort du Homet. It is considered that it would be imprudent to attempt to beat in at night through the West Passage with large ships, unless there is moonlight.

The flood tide sets here S.E. and E.S.E., running 3 miles an hour at its greatest strength, and begins $1^h\ 30^m$ after low water by the shore, and ends $1^h\ 20^m$ after high water at the military port; the ebb current nearly the same, running to N.W.

The passage between *Forts Querqueville* and *Chavagnac* is now being closed to all but small vessels by the construction of a breakwater between these forts.

The Eastern Entrance is comprised between the East end of the Digue and the western slope of the Pelée Island Flat; the most dangerous points of it are marked by buoys. It is separated from the East part of the Great Road by the Pelée Island Bank, the least depth on which is 21 feet. Besides being very narrow, it is inconvenient from the currents crossing it obliquely. This renders it dangerous for sailing vessels in light winds, and impracticable for them in calms.

The approaches to Cherbourg are facilitated at night by the following lights: On the Guardhouse of Fort Querqueville is a *fixed bright* light, elevated 59 ft. above high water, and visible 9 miles. A *lifeboat* is stationed here.

On the Central Fort of the Digue, 2½ miles E. by S. ½ S. from the former, is a *fixed bright* light, varied by a *flash* every 3 minutes, elevated 66 ft., and visible 13 miles. On the fort on the East end of the Digue, at 8 cables S.E. by E. ½ E. from the Central Fort light, is shown a *fixed green* light, elevated 63 ft., and visible 5 miles. On the fort on the West end, 1⅛ mile W.N.W. from the Central Fort light, is shown a *fixed red* light, elevated 62 ft., and visible 7 miles.

On the N.E. bastion of the Fort on Pelée Island, about 5¾ cables S.E. by E. ¾ E. from the green light on the Eastern Fort, is a *fixed bright* light, elevated 85 ft., and visible 9 miles.

A *fixed red* harbour light is placed at the end of the East jetty of the Port du Commerce, at 33 ft. above high water, visible 5 miles; and a *fixed green* light on the West jetty.

Cherbourg, besides its important position as a naval arsenal, carries on a considerable commerce, the exports mainly consisting of agricultural produce, and broken stone for roads. Vessels drawing 17 ft. can enter the inner harbour and floating basin. Supplies are plentiful, and coal can also be obtained. Ordinary repairs can be executed here, there being a gridiron, slips, and dry dock for the use of merchant vessels.

The great bay which is formed on the coast between Cape la Hague and the Bréhat Isles, in which lie the Channel Islands, is most dangerous to the stranger. Its furious tidal streams, and the countless rocks which cover and uncover to an enormous extent in the great range of tide, render it impossible in a few words to describe any of its navigation. Indeed, local and intimate knowledge alone can conduct a ship safely through any of its intricate passages.

ALDERNEY or Aurigny.—The eastern end of Alderney lies 8½ miles W.N.W. of Cape la Hague. This island is about 3½ miles in length by an average breadth of nearly a mile, and its coasts are surrounded with rocks, which render the navigation difficult and dangerous; more particularly as the tides set strongly, and in various directions. It possesses but two small harbours, both dry at low water neaps; one, called *Port Longy*, on the south-eastern side of the island, and the other, the old harbour of *Braye*, on the northern side. Braye is the chief port, and on the western side of Port Longy is a signal post.

The English Government constructed some extensive harbour works in Braye Bay, to form a Harbour of Refuge, but the breakwater has been so damaged by storms that the works have been all but abandoned. The N.W. breakwater extended 1,609 yards in a curved and E.N.E. direction from the cape, and sheltered from westerly and N.W. gales the space within a line drawn S.E. by S. from the outer end of the breakwater to Roselle Point, including Braye Road, the old harbour of Braye, and the new harbour of *Craby*, which dries at low water springs, and was constructed for the use of vessels employed in bringing material for the breakwater works.

Strangers entering must beware of the remains of the breakwater, which partly dry at low water, and extend 3 or 4 cables beyond the visible extremity.

BAY OF BISCAY.—In former pages, when the best routes to the southward were considered, the indraught into the Bay of Biscay was especially mentioned as a tendency to be avoided. (See pages 301—312, 479, &c.) But as it may sometimes happen that a vessel may get embayed without being able to weather its outer points, a few remarks on its more available roadsteads will be given here. The Sailing Directions accompanying the chart give a full description of the coasts and harbours, and in "Lighthouses of the World" is given a list and descriptions of these monitors which well mark its coasts, and by means of which a ship may avail herself of many anchorages, which it would occupy too much space to describe here.

USHANT (*Ouessant*) is a steep craggy island, about 4½ miles in length, East and West, and 2 miles in breadth, rising to a height of 195 feet. On its S.W. side is a harbour, that of *Lampoul*, but of difficult access. The rest of the island is surrounded with rocks, a part of the North side excepted, where there is anchorage between Ushant and a little island called *Queler;* here small vessels may lie sheltered from all winds but those from the northward. The N.E. and N.W. extremes of Ushant are each marked by a fine *flashing light*, visible 20 miles in ordinary weather, but the glare is sometimes seen for double this distance. There is a *Fog Signal* and Commercial Code *Signal Station* near each lighthouse. The island fishermen are qualified to act as pilots for the intricate channels around.

Chenal de Fromveur, the passage between the southern side of Ushant and the assemblage of islets and rocks to the S.E., though deep cannot be recommended, owing to the fearful rapidity of the tidal streams, and it is dangerous in bad weather.

Chenal du Four, passing between Ushant and the above rocks and the main, is navigable by large vessels, though the tides run rapidly through it, attaining a rate of 6 to 7 knots at springs, sometimes causing dangerous rips.

The Iroise, the approach to Brest and Douarnenez, is encumbered with rocks and shoals, between which there are deep channels. The tides are not strong in the central part. In fine weather, with easterly winds, there is anchorage in deep water near the Pierres Noires. Farther in there is good sheltered anchorage in *Camaret* and *Bertheaume Bays*. This district is well lighted, and the dangers marked by buoys and beacons. Minou and Portzic lighthouses in line, bearing E. ¼ N., lead clear of all danger from abreast Pierres Noires lighthouse up to the entrance of the *Goulet*, the strait leading from the outer bay of Brest into the extensive sheltered area known as *Brest Roads*, available for vessels of the greatest draught. On the North side of this roadstead, some harbour works are in progress, southward of the town.

BREST, as a port of refuge, may perhaps be considered the best and safest in France, and the coast of Finistère being a very dangerous one in bad weather, it often serves as a safe shelter to merchant ships; while, in case of casualties to shipping, it affords great facilities for repairs, &c. The maritime authorities render every assistance, and are on all occasions ready at a fixed and moderate charge, to send steamers to the aid of vessels in distress. Supplies of all kinds, including coal, can be obtained here, and in case of need the Government dry docks are available; they will admit the largest vessel afloat.

Douarnenez Bay.—This capacious bay, which lies to the southward of Brest Harbour, will accommodate a large fleet, being 10 miles deep and about 7 miles wide. Its entrance is so wide, and its bottom altogether so clear and regular, that no leading mark is required; provided that sufficient berth be given to the *Basse Vieille*, in the middle of the entrance, and to several rocks which lie on the North side, as represented on the charts. The *Basse Vieille* uncovers about 5 ft. at low water, but is steep-to, having from 17 to 12 fathoms close to. Its bearing and distance from the Bec de Chèvre are S.W. by W., 2¼ miles, and the light on *Millier Point* shows *red* over it; a *black buoy* lies off its southern side. When past the Basse Vieille, you may steer for what part of the bay you please, all being fair and clear, excepting what may be seen above water, and what may be near the shore. The best ground, however, is considered to be that toward the North side, being clear sand, with depths of 9 to 15 fathoms. The general depths over the bay are from 18 to 12 fathoms.

The village of *Douarnenez* stands on the southern shore of the bay, and a *fixed red light* is shown on the head of the mole. *Tristan Island*, on which is a lighthouse showing a *fixed bright light*, visible 10 miles, lies off the village, and at about three-quarters of a mile northward of it is the outermost of two small sand patches, with 17 and 8 ft. water respectively, which lie with the centre of the island in line with Plouaré Church. There is good anchorage off the village in 5 or 6 fathoms.

The Chaussee de Sein (Saints' Bridge) requires but little description, as it is clearly exhibited on the chart, and the lighthouses, by means of which its position is indicated at night, are fully described in "Lighthouses of the World." This extensive chain of foul ground trends 9 miles N.W. by W. ¾ W. from the lighthouse on the principal island, and is studded all over with rocks, some above water. From the westernmost patch of 3¾ fathoms, Ushant N.W. lighthouse bears N. by E. ¼ E., distant 24 miles; Ar-men Rock lighthouse, S.E. by E. ½ E., 3 miles; and Ile de Sein lighthouse, S.E. by E. ¾ E., 8½ miles, and a little open southward of Pointe du Raz. The lead is of little or no use here, depths of 30 to 40 fathoms being found within a mile of the rocks, and the tides are strong and uncertain.

Glenan Islands are an extensive group of islands and rocks, separated by channels only available for vessels of light draught; there is deep water in the passage between them and the main, but scattered dangers obstruct it. There is good anchorage in 15 to 18 fathoms, mud, at 1 to 2½ miles off the East and N.E. sides of *Penfret Island*, on which is a lighthouse, with three wells of excellent fresh water. Ile aux Moutons lighthouse bearing N.W. by N. ½ N., open North of Penfret, leads safely between the Glenan Islands and Basse Jaune Shoal.

Ile de Groix, 18 miles S.E. by E. from the Glenan Islands, is 4¼ miles long, with a lighthouse on each extremity. The channel between it and the main land, 3 miles distant, has 8 to 19 fathoms in it, forming the approach to *Ports Louis* and *L'Orient;* the latter is a naval arsenal.

BELLE ILE is high, and may be seen from a great distance, and in the channel between it and the coast vessels find shelter from West and S.W. winds. Its N.W. end, in lat. 47° 23′, is surrounded with rocks; its South point is in lat. 47° 16′. Between the North end of the island and the Ile de Groix, lies the rocky bank called the *Birvideaux*. On the South side of the island there are many rocks near the shore, both above and under water. The shores of Belle Ile are well lighted.

If a ship, with the wind at N.W. or W.N.W., keeps between the latitudes above mentioned, when running for the island, on approaching she may steer along the South side at the distance of 2 miles, to *Pointe de l'Echelle* or *des Canons*, the S.E. extremity. From this point haul up for *Pointe de Kerdonis*, the easternmost point, which is situate 2¼ miles from the former. Under this point may be found anchorage, in from 15 to 8 fathoms, sheltered from N.W. and westerly winds. Should the wind here veer to S.W., a ship may run to the northward of the point, and anchor on the N.E. side of the island.

Hædic Island, which lies about 7 miles East of the East end of Belle Ile, has many rocks, with foul ground about them. The *Cardinals* extend to the S.E. from Hædic, and the lighthouse near the extremity bears E. by S. ½ S., 9 miles, from the lighthouse on Kerdonis Point, Belle Ile. Should a ship be driven to the eastward of Belle Ile, she must give the Cardinals a good berth, and may then haul up to the northward for the anchorage.

In the *Bay of Quiberon*, after you have brought the Cardinals to bear S.S.W., S. by W., or South, there is good anchorage, with clear soft clay, and very even soundings, in from 10 to 12 fathoms. With these bearings, you will be within the foul rocky ground of the Plateau de l'Artimon, lying N.W. of the Cardinals.

LOIRE RIVER, one of the principal rivers of France, has its entrance obstructed by an extensive flat with depths of 9 to 16 ft. over it at low water, and besides this the approach is encumbered with rocky banks. *St. Nazaire*, on the North side of the entrance, carries on a large trade, and has dry docks and every convenience for the building and repair of vessels and their machinery. Vessels drawing up to 26 ft. have entered the port, where coal and other supplies can be readily obtained. About 30 miles above St. Nazaire is the flourishing town of *Nantes*, which can now be reached by vessels drawing 17½ ft. at high water springs, but when the canal under construction is completed, vessels drawing 19½ ft. will be able to reach the town.

Pilots will be found cruising off the entrance of the river, and strangers should not attempt to enter without their assistance. The dredged channel over the bar is marked by *buoys* bearing *red* and *green* lights.

Bourgneuf Bay, within the *Ile de Noirmoutier*, affords good anchorage on its South side, in 5 fathoms, sand and mud, but is not safe in N.W. gales. The navigation of the bay is much obstructed by rocky shoals.

Ile d'Yeu, lying 9 miles off the coast, is 5½ miles in length, the most prominent objects on it being the lighthouse, 108 ft. high, and the church and steeple of St. Sauveur. Depths of 3 to 5 fathoms are found in the channel between the island and the bank extending off the coast, and it is unsafe for vessels of over 16 ft. draught at low tide. The best anchorage around it is in 5½ fathoms, 2½ miles N.N.E. of St. Sauveur church. Vessels can also anchor off the South side of the island, not approaching the shore within half a mile.

Roche Bonne.—This very dangerous shoal is a great rocky flat, 2 to 3 miles in width, lying between the parallels of 46° 9′ and 46° 16′ N. On its N.W. part is a rocky head with only 10 to 15 ft. water over it, lying 36 miles W. by N. ½ N. from the lighthouse on the N.W. end of the Ile de Ré. Deep water is found close to the sides of the bank, and too much confidence must not be placed in the *lightvessel* retaining her station to the eastward of it.

The rocky bottom, to the N.N.W. of the Roche Bonne, is known to the fishermen under the name of *Banche Verte*, and is not dangerous. Westward of the rocks, in all their extent, the bottom is of mud.

Ile de Re', 13 miles long N.W. and S.E., forms the South side of the *Pertuis Breton*, where vessels find anchorage in 9 or 10 fathoms, clear of the banks, and sheltered from all winds but those from the northwestward. The passage between the S.E. end of the island and the coast is blocked by a muddy flat, on which there is only 8 or 9 ft. at low water. Vessels in distress might run aground on the soft mud in *Aiguillon Bay*, the N.E. angle of the Pertuis.

Ile d'Oleron, 16½ miles in length, is almost surrounded by shoals and rocky reefs, rendering dangerous the *Pertuis de Maumusson*, the narrow winding passage between the S.E. end of the island and the main. *Pertuis d'Antioche*, the passage between the Iles de Ré and d'Oléron, leading to Basque Road, is nearly 7 miles in width, with depths of 12 to 20 fathoms in mid-channel, shoaling towards either side. The tides in it are strong, and a stranger should secure the aid of a pilot.

Basque Roads.—In navigating the Pertuis d'Antioche, to avoid the rocky flats off the North end of Oléron and the banks off the S.E. end of Ile de Ré, it is advisable to keep in mid-channel, keeping in depths over 9 or 10 fathoms, until Chauveau lighthouse bears N.N.E. Then steer for the West part of the *Ile d'Aix*, a low fortified island, which lies about halfway between Oléron and the mainland, and has a lighthouse on its South point, which bearing S.E. ½ S. will clear the shoals and rocks off the East side of Oléron, and lead to an anchorage in the southern part of Basque Road. The roads extend from *Lavardin Shoal*, which is marked by a tower, to this little island, and have depths of 12 and 13 fathoms in the middle of them; and depths from 5 to 9 fathoms at about 1½ mile to the North and N.W. of the Ile d'Aix. There is 6 fathoms at 1½ mile West from the island, and good ground. The French Man-of-War Road is on the S.W. side of the Ile d'Aix.

Port La Pallice is a large artificial harbour, opened in 1890, constructed on the mainland in the northern angle of Basque Roads. It is furnished with every modern appliance, including large dry docks, and is available for vessels of the largest size, having a depth of 35 ft. at high water springs. It is connected with La Rochelle by railway. The roadstead off it is good, and well sheltered.

La Rochelle, about 2½ miles eastward of La Pallice, has a considerable trade, and vessels can here obtain all necessaries, including coal and repairs. The outer harbour nearly dries at low water, but vessels lie afloat in the wet docks, the outer one of which has a depth of 23 ft. over the sill at high water springs. Vessels up to 22 ft. draught can enter the port.

CHARENTE RIVER is navigable for small vessels as far as *Montignac*, 60 miles from its mouth, but at low water its entrance is blocked by a shallow flat. At 10 miles up the river is the important town of *Rochefort*, which can be reached by vessels of the largest draught at high water springs; at low water the depth in the river is 18 to 20 feet. Being a naval arsenal, supplies of all kinds are abundant, and there are ample facilities for docking and repairs. Spring tides here rise 16¾ feet. At 3½ miles above Rochefort is *Tonnay-Charente*, which can be reached by vessels of large draught.

GIRONDE RIVER.—The estuary of this noble stream is about 14 miles in width, but is encumbered with shallow banks impeding its navigation. Care is requisite at all times, as the banks and channels are liable to shift. The limits of the banks and the channels are well marked by *buoys*, but they may drift in bad weather. We cannot here enter into a minute description, and the lights which facilitate its navigation are fully described in "Lighthouses of the World."

The Tour de Cordouan forms a prominent landmark for the river entrance, as it stands nearly in the centre. It is a circular tower, 207 ft.

high, considered to be the most elegant lighthouse in existence, and was completed in 1665. Seaward it shows a *bright revolving* light, attaining its greatest brilliancy once every minute, elevated 196 ft. above high water, and visible 21 miles.

Large vessels should not attempt to enter without a pilot, and they are often found cruising well to seaward; in bad weather they take shelter in the Pertuis d'Antioche or Pertuis Breton. Steam-tugs are always available. Great caution is requisite on making the river, should the landmarks be obscured by thick weather, or if night comes on; it will then be prudent to anchor in the first convenient spot.

There are only two channels for entering the Gironde, which can be used with safety: these are the *Passe du Nord*, or Passage by the North shore; and the *Passe de Grave*, or Southern Passage. For each of these passages there are various distinguishing marks, buoys, and beacons, independent of the lights; but it cannot be too much insisted on that notwithstanding these facilities, vessels should never attempt to enter the Gironde by night, except in cases of necessity: seeing that the dangers are then multiplied, and that the fog often prevents the lights from being seen. Sailing vessels should not attempt to enter in hazy weather, with a calm.

The *Tides*, both ebb and flood, set strongly through the channels, and the rise at springs is 16¾ ft.; at high springs the phenomenon of the "mascaret" or "bore" sometimes occurs, often causing serious damage, as its crest rises 13 to 16 ft. above the ordinary level.

At the entrance of the Passe de Grave, with the Cordouan Tower bearing N.E., the tides set at follows:—First of the flood, North; one-third flood, N.E.; half and two-thirds flood, E.N.E. First of the ebb, S.E.; one-third ebb, South; half and two-thirds ebb, West. In the channel within, with the tower bearing N.N.W., the flood sets, generally, E.N.E., and the ebb, W.S.W. Between the Grand Bank of Cordouan and the Pointe de Grave the flood sets, generally, S.E.; the ebb from West to W.S.W.

Passe du Nord has depths of 21 to 36 ft. in its entrance at low water, but is much deeper inside. To enter, steer for the lighthouse on Coubre Point, in line with Palmyre Point lighthouse, bearing S.E. by E. ½ E., and when distant 5 miles, the vesssl will be up to the fairway buoy moored outside the bar. Continue on this course till Grand Banc lightvessel is open about 3° eastward of the Cordouan lighthouse, which is the mark for passing between Mauvaise Shoal and Coubre Bank. Pass northward of the lightvessel, and bring Falaise and Terre Negre lighthouses in line, keeping them so till off Pointe de la Palmyre; then alter course to S.E. ¼ E., with St. George and Suzac lighthouses in line, and keep them so till Tallais Bank lightvessel and Richard lighthouse come in line, which latter mark leads up to the Rade de Verdon. Should circumstances require it, you may run up and take shelter under the Pointe de Grave, which affords a safe retreat during westerly and S.W. winds.

Passe de Grave, 12 miles southward of the Passe du Nord, is 8 miles in length, with a depth of 12 ft. at low water. In going through it, be cautious of advancing too near the shore, as the tide of flood sets strongly upon it; and never, if avoidable, attempt to anchor in it. No large vessel should attempt to navigate this channel, unless with a rising tide, and favourable wind if a sailing vessel.

To enter the Passe de Grave, bring the Cordouan tower to bear N.E. by E., and steer for it until nearly up to the fairway buoy. When St. Nicolas and Pointe de Grave lighthouses come in line, E. ¾ N., alter course, keeping them so until Chay and Pierre de Royan lighthouses come in line, N.E. by E. ¾ E., and this mark will lead on till Tallais lightvessel and Richard lighthouse come in line. By following these directions a least depth of 12 ft. will be found at low water; otherwise not more than 8 ft. can be relied on.

Within Pointe de Grave the fine estuary of the Gironde is above 5 miles in breadth, with a depth of from 6 to 12 fathoms; but there are numerous shifting banks which occupy the central part.

Pauillac, on the Medoc or western bank, 27 miles above Pointe de Grave, can be reached by large vessels, the least depth found in the channel up to it being 2½ fathoms at low water. Vessels, whose draught will not allow them to reach Bordeaux, lie here to receive or discharge their cargo. At 5 miles higher up, on the opposite bank, is the picturesque old town of *Blaye*. At 7 miles above Blaye is the confluence of the *Rivers Dordogne* and *Garonne*, the streams of which united form the Gironde.

Bordeaux, one of the finest cities of France, containing 252,054 inhabitants at the census of 1891, is situated 11 miles up the Garonne, or about 50 miles from the sea, and can be reached by vessels drawing 19 to 20 ft., at high water. A vessel drawing 22¾ ft. has reached the port. Here are numerous docks and building-yards, with every facility for repairs of vessels and their machinery, and supplies of all kinds, including coal, are abundant.

Adour River is a rapid stream with a shifting bar, rendering its navigation difficult for sailing vessels. At high water neaps, vessels drawing up to 14 ft. can cross the bar, with the aid of a pilot, and at high water springs vessels drawing 18 ft. have reached Bayonne. The bar is passable for sailing vessels during daylight only, and with the flood tide; but under favourable circumstances, in fine weather, it may be crossed at the beginning of the ebb. It is not always the depth of water which prevents a vessel crossing, but the heavy sea caused by the ebb tide. The sea is often smooth in the offing when the bar is impassable.

Bayonne, about 3 miles from the sea, stands on the left bank of the Adour, at its confluence with the *Nive*. Here is a naval arsenal, and vessels can have small repairs executed. Provisions and other supplies, including coal, are plentiful.

In a sailing vessel, care should be taken, when bound for the Adour, to keep to the northward of the entrance, if the wind has previously prevailed from N.N.W. to East; but to the southward of it, when the wind has prevailed for five or six days from South to W.N.W. Experience proves that in the former case the current sets to the S.W., and that vessels have sometimes been carried down to the coast of Spain; and, in the latter, they have been drifted northward of the bar, where, finding no shelter, and being unable to keep off the land in bad weather, they have been stranded between the Adour and Vieux Boucaut.

To the North of the Adour there is no anchorage in bad weather, not even in the Fosse of Cap Breton. A vessel may, however, run for a chance of saving her crew on the beach at the head of the Fosse; but, to gain the entrance in bad weather, it is necessary to work off about 6 miles from the coast. To the North and South of the Fosse the sea breaks heavily on the sandy flats, where it is scarcely passable. It may be worthy of notice that in the event of unusually bad weather, and when a vessel can neither pass the bar nor remain in the open sea, she can often seek refuge in the roadstead of St. Jean de Luz.

St. Jean de Luz Bay, 12 miles S.W. by W. ½ W. from the Adour, is three-quarters of a mile wide and half a mile deep, and affords anchorage in 3 to 6 fathoms, sand and rock, or vessels may secure to mooring buoys. It has been made suitable for a harbour of refuge in bad weather by constructing a mole, rising 20 ft. above the sea, from Socoa to the eastward, into a depth of 5 fathoms, and a breakwater is under construction on *Artha Rock,* in the middle of the entrance, leaving a deep channel on either side. A red or tricoloured flag indicates that a vessel can enter the port; when it is hauled down, and a flag hoisted on the end of the jetty, the vessel should anchor.

In entering St. Jean de Luz Bay at night, bring Socoa *fixed bright* light to bear S.S.E., and steer for it; when the two *fixed red* lights on St. Barbe Point are in line, alter course and keep them so until the two *fixed green* lights at Siboure are in line; this last course leads between Socoa mole and Artha breakwater. When Socoa light has changed from *bright* to *red,* haul to the S.W. for the anchorage, and anchor when the light appears *bright* in the anchorage.

THE COAST OF SPAIN.—Off the North coast of Spain, which is high, bold, and rocky, the depth of water, in general, is from 150 to 200 fathoms, foul ground and coral; but in many places, there is no bottom at that depth, even near the shore. The principal harbours on this coast are those of Bilbao and Santander, and a full description is given in the Sailing Directions accompanying the Chart.

Port Pasages is a narrow winding inlet, with 13 fathoms water in the entrance, gradually decreasing to 3 fathoms off the town, half a mile within. Provisions and coal can be obtained here, and small repairs executed at a foundry. Fishermen are always on the look-out to act as pilots, and no vessel should attempt to enter without one. The entrance is easily made out from seaward, and in thick weather the deep-sea lead will act as a guide in approaching, the depth decreasing from 70 to 75 fathoms, about 10 miles off, to 30 and 25 fathoms, at 2 miles off.

San Sebastian, about 3 miles westward of Port Pasages, is a strongly fortified town, situated on the shores of a beautiful bay. Vessels entering, which they should not attempt to do in bad weather, pass between Mount Orgullo and Santa Clara Islet, in depths of 5 to 9 fathoms, but the anchorage is exposed to gales from N.W. to N.E. Small vessels enter the basin, which nearly dries at low water. Coal and other supplies can be obtained here.

Guetaria Bay, about 7½ miles westward of San Sebastian, offers good anchorage in 3 to 8 fathoms, sand and mud, in S.W. gales, when vessels should not attempt to enter San Sebastian and Pasages. San Anton Island and its lighthouse mark the approach, and the best anchorage is in 5 fathoms, sand, off the pier. It is sheltered from the westward as far round as N.N.W., but with strong winds from the northward and N.E. a terrific sea sets in.

On *Cape Machichaco*, 12 miles to the eastward of Bilbao Bay, is a lighthouse, showing a *fixed bright* light, varied by a *flash* every 4 minutes, elevated 268 ft. above high water, and visible 20 miles.

BILBAO BAY is an inlet, running about 3 miles into the land in a S.E. direction, between Points Galea and Lucero or Luzuero, which bear W. by N. and E. by S. from each other, 3 miles apart. From its entrance, where the depths are 14 and 15 fathoms, sand, the bay gradually narrows and shoals to its head, where the River Nervion disembogues. The greater part of its coast is lofty, steep, and rocky; but the bottom of the bay, on the eastern side, is low and sandy. On Galea Castle, at half a mile southward of Galea Point, is shown a *fixed bright* light, elevated 401 ft., and visible 10 miles.

The mouth of the river is impeded by a shifting bar, within which is the town of *Portugalete*, and off which is the best anchorage in the harbour. In winter a heavy sea sets into the bay, which at times renders it impossible for the pilots to go off. Harbour works are now in progress at the entrance of the river, and the bar is being deepened. At present the depth over it is 26 ft. at high water springs.

Bilbao, 8½ miles above the mouth of the river, can be reached by vessels drawing 16 to 17 ft., and is a busy town, exporting large quantities of iron-ore. Shipbuilding is carried on here, and supplies of all kinds, including coal, may be obtained. There are dry docks and other facilities for the repair of vessels and their machinery.

In coming in, when the tide does not serve for taking the bar, with an unfavourable wind, you may come-to in the bay, midway between the outer points, Luzuero and Galea; bring the latter in a line with Cape Villano, in 16 fathoms, with sandy bottom. There is here sufficient room, in case a heavy on-shore wind should bring home the anchor or part the cable, to let go a second anchor, before the ship can get ashore. In summer you may lie nearer to the land, in from 10 to 12 fathoms, all the bottom being of sand.

On making the bay from the westward, Point Galea, on the eastern side, may be readily known by its white colour and lighthouse. Should you pass Santona, the bay may be thence distinguished by three sharp-pointed mountains; of these the northernmost is that of *Luzuero;* the middle one and highest, the hill of *Scrantes,* on the West of the bay; the southern one appears like an island. On steering for the first, you will of course make Point Luzuero.

Pilots seldom await vessels eastward of Bilbao, as the land is generally made to the westward. The chief pilot, whose duty is to guide vessels across the bar, is always in attendance at the signal tower at Portugalete; pilot boats will be known by a *red flag*.

SANTANDER.—This port is the best on the coast of Spain, eastward of Cape Ortegal, but it should not be attempted by a stranger, as the tides are strong, and the banks within, formed by the deposits brought down by the streams which discharge into it, frequently shift. Neither should it be attempted in a N.W. gale if the vessel can keep the sea; and even after the gale, for a day or so, it should be approached by a sailing vessel with caution, in order not to get so far embayed as to be unable to haul out again, should the bar (as it is termed) be up; for at this time from Mouro Islet to Puerto Point, and across to the Puntal Sands, is one confused sea, breaking in 7 and 8 fathoms water.

Cape Mayor, with its *revolving light*, is on the western side of the entrance; *Cape Menor*, half a mile more to the S.S.E., has a battery on it, and is lower than Cape Mayor, and terminates in a low flat point, with a small reef of rock below it. On the same side, at 1¼ mile S. by E. of Cape Menor, is Point Puerto, where a *green* light is shown from a brick tower. Vessels coming from the westward will not sight this light until it bears about S. ½ W., on which bearing it clears the shoal water off Cape Menor.

The land between Cape Menor and Point Puerto forms the sandy *Bay of Sardinero*, in which vessels anchor, when the wind and tide do not serve for going into the harbour. The best anchorage here is in 9 fathoms, sand, 3 cables South of Cape Menor; but more to the southward the bottom is rocky.

Mouro Islet, which is high and steep, lies in the entrance at half a mile N.E. of Puerto Point, and the lighthouse on it shows a *fixed bright* light. Close off its eastern side is a large rock, and there is a shoal at a cable's length to the N.W. of it; otherwise there is deep water around it, and the channels on each side are clear and good. *Puntal Sands*, the extensive sands on the South side of the harbour, frequently shift, and a great portion of them dry at low water.

With the wind blowing fresh from the S.W. or N.W. quarters, it is impossible to take the *harbour* of Santander; but vessels may, with flood tide, occasionally bring up in the Road of the Promontory, which is clean and roomy, and there wait for a wind. With an ebb tide it will be better to come-to in the outer bay, off the beach of Sardinero, as already described. Pilots are usually waiting under the lee of Puerto Point.

Santander, 1¼ mile within Puerto Point, is a busy town, picturesquely situated, with every convenience for the accommodation of shipping. A vessel drawing 25 ft. has entered the port. Supplies, including coal, can be obtained here, and there are facilities for the repair of vessels and their machinery.*

On *Cape Peñas* is a *revolving* light, visible every half minute; on *Cape*

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* On November 3rd, 1893, a disastrous explosion of dynamite occurred on board the steamer *Machichaco* lying in the harbour, causing great loss of life and enormous destruction of property, and wrecking the quays. It will take a long time for Santander to recover from the effects of this catastrophe.

Busto (long. 6° 29′) is a *fixed bright* light with a *red flash* every 2 minutes; on the *Orrio de Tapia*, near Ribadeo, is another *fixed and flashing* light; and on *Cape Estaca* is a *revolving* light. These principal lights, with the others described in the Light Book, indicate the chief points of the coast.

Gijon Bay is quite open to the N.E., but its western part affords shelter from westerly winds. The shore is nearly all bordered by a rocky flat, and the darsena or basin will only admit vessels drawing about 13 ft. at high water. Large vessels anchor in 10 or 11 fathoms, sand, with the town of Candas (about 4 miles N.W. of Cape Torres) just shut in with Orrio Islet, at the foot of the cape, and distant about 4 cables from the islet. Small vessels anchor in 8 or 9 fathoms. Fresh water and other supplies, including coal, are plentiful, and repairs can be effected. In bad weather, vessels bound here from the westward should give Cape Peñas a berth of 5 or 6 miles, to avoid the heavy sea off it.

Port Vivero affords good anchorage, with shelter from S.W. and N.W. winds on its western shore, and from N.E. and East winds on its eastern shore. Northerly winds send in a heavy sea. The depths decrease gradually from 12 fathoms in the entrance, which is 1 mile wide. Vessels drawing less than 11 ft. can reach the town of *Vivero*, where good water and provisions can be obtained.

Barquero Islet is spacious, and of easy access, affording good anchorage for large vessels, sheltered from all winds but those from the eastward. Its superiority consists in the facility of taking it in bad weather, the coast being clean and bold. Water is plentiful here, but other supplies are not abundant.

CAPE ORTEGAL and Cape Prior, with the other headlands in the vicinity, are high and steep, and the ground without generally rocky and foul. At the foot of Cape Ortegal are nine or ten sharp-pointed rocks above water, with 15 or 16 fathoms close to them; and there is a rocky shoal of 2½ fathoms at half a mile northward of the point. A watch-tower on the highest land, at 1⅔ mile from the cape to the southward, is a good mark for distinguishing it from seaward. Hence to Cedeira the land is steep and rugged, but to the northward of Cape Prior it falls into sandy bays. At various distances from shore are many scattered rocks, on which the sea breaks in a swell.

Both the stream of tide and current of the sea set in toward the land of this coast; so that the utmost attention is requisite, in order to avoid being embayed with light winds. With a good steady breeze, large ships may, however, pass safely within 2 miles of Cape Ortegal.*

FERROL.—From Cape Prior, which is marked by a lighthouse showing a *fixed bright* light, to the Harbour of Ferrol, the land is highly mountainous, with large rocks above water along shore. On Cape Prioriño, 6½ miles S.W. by S. ½ S. from Cape Prior, a *fixed bright* light, varied by a *red flash* every 2 minutes, is shown. This cape, which forms the North side of the entrance of Ferrol, may be rounded at the distance of half a mile or less. The bay, forming the entrance of Ferrol Harbour, is only 1¼ mile wide; and the channel from it into the harbour but 2 cables' lengths in its narrowest part, but there is, nevertheless, sufficient depth in mid-channel for large ships at all times of the tide, viz., 8 to 10 and 12 fathoms.* When within, keep over to the North side, where you may haul up and anchor in from 4 to 6 fathoms, sheltered from all winds. Large vessels anchor in 7 to 9 fathoms, in the middle of the bay. In fine weather, with a fair wind, there is no difficulty in entering Ferrol, but it is not prudent to approach this harbour or Coruña at night in thick weather, as the lights cannot be depended on.

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* *Caution.*—Commanders and other officers of vessels are earnestly advised to exercise the strictest vigilance when making the N.W. extremity of the Spanish Peninsula from the northward, taking warning from the numerous disastrous casualties which have occurred here, as recorded previously in pages 308—309.

Supplies of all kinds, including coal, are abundant at Ferrol, and the Government dockyard undertakes all kinds of repairs to vessels and their machinery. H.M.S. *Howe* here underwent, in dry dock, the necessary patching up to enable her to proceed to England.

Ares and *Betanzos Inlets*, in the deep bight between Ferrol and Coruña, are both exposed to West and N.W. winds; the holding ground is good. *Miranda Bank*, lying nearly in the middle of the entrance of the bight, helps to shelter the anchorage from the heavy N.W. seas.

CORUNA BAY is deep and spacious, but open to northerly and N.W. winds, from which shelter may be obtained off the town. Its western side is formed by a rocky peninsula, on the northern end of which is the remarkable lighthouse called the *Tower of Hercules*, exhibiting a *fixed bright* light with a *bright flash* every 3 minutes. A range of rocks extends a considerable distance N.W. of the lighthouse point, and the eastern coast of the peninsula is foul and rocky. In bad weather, *Jacentes* and *Cavanes Banks*, lying off and in the entrance, are covered with breakers. With a heavy N.W. sea the entrance is sometimes completely barred by breakers. Vessels anchor off the town, in 4 to 5 fathoms; but those of heavy draught must anchor eastward of the meridian of San Antonio Castle, exposed to the sea with northerly winds.

Supplies can be readily obtained at the town, but there is no dock accommodation. Coal is stored in considerable quantities.

At 19 miles W. by N. ½ N. from Coruña is San Adrian Point, off which are the *Sisargas Islands*. On the largest of these stands the lighthouse, which shows a *fixed bright* light, varied by a *red flash* every 4 minutes. From San Adrian Point, the high land continues to the Bay of Camarinas, with rocks above and under water. *Cape Villano*, on which is a lighthouse,† is of rock, not very high, but perpendicular toward the sea. Within it, at a short distance, is a sharp peak, of a red colour, which at a distance appears like a tower. About half a mile N.N.W. from the cape lies *Bufardo Rock*, steep-to, and over which the sea breaks.

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* It will not be forgotten that H.M.S. *Howe*, in fine weather and broad daylight, on November 2nd, 1892, was here ignominiously run aground "on an unknown shoal" (that lining the Northern side of the channel), though navigated by an "official" Admiralty chart. She was ultimately floated at great expense, and brought back to England and repaired.

† A new lighthouse has been erected on the high land about 1 mile northward of the old lighthouse on Cape Villano, which stands in a bad position, and the old light is to be transferred to a lighthouse on Cape Torinana. Cape Villano new light will be a *double-flashing electric* light, every 15 seconds.

CAPE TORINANA, 9 miles S.W. ¾ W. from Cape Villano, is a sharp and steep projection, not very high, and with a lighthouse on it; at a distance it is not always distinguishable from the high land at the back of it. About 1 mile W.N.W. from Cape Toriñana lies *African Rock*, which breaks in rough weather, but its position is doubtful. This coast must be avoided as much as possible on account of the sunken rocks lying off it.

The *Navé of Finisterre*, 5¾ miles S. by W. ½ W. from Cape Toriñana, has a flat summit, 780 ft. high; at about one-third of its height from the sea shore there appears to be a short projection with hummocks on it, and at its base is a high islet. In the bay, formed between Lemiña Point and the Navé of Finisterre, vessels may safely anchor during N.E. and easterly winds, off a fresh-water rivulet, in from 6 to 8 fathoms, sandy bottom, but not in deeper water, as there the bottom is rocky. Care must also be taken not to advance too near the North shore, as it also is foul. A sunken rock of 3 fathoms, on which the sea breaks in bad weather, lies 1¾ mile N.W. by W. ¼ W. from the Navé.

CAPE FINISTERRE, about 1½ mile South of the Navé, may be readily known from sea; because there is a bight between it and the Navé with a low beach, and the land behind is less elevated. As there are no other points like these on the neighbouring coast, they cannot easily be mistaken. There is a lighthouse on it, which shows a *revolving bright* light at half-minute intervals, and in foggy weather a *Siren* is sounded. Near the lighthouse is a *Signal Station*.

Corcubion Bay, the deep bight eastward of Cape Finisterre, affords good anchorage for the largest vessels, in from 7 to 13 fathoms, well sheltered from all but southerly winds, between the forts at the approach to the town of *Corcubion*. Welsh coal may be obtained here.

Arosa Bay extends about 13 miles in to E.N.E., with a breadth varying from 2 to 7 miles, possessing many good and well-sheltered anchorages. Its entrance is well marked by Salvora Island and its lighthouse, within and around which there are many rocky reefs and islets, but there is no difficulty with daylight and a leading wind. At the head of the bay is the town of *Carril*, off which there is good anchorage in 7 to 9 fathoms. Pilots may usually be obtained at Salvora Island.

Pontevedra Bay, off which lies *Ons Island* with its lighthouse, is of easy access, but only affords good anchorage for large vessels during summer.

Vigo Bay, sheltered from the westward by *Cies* or *Bayona Islands*, extends about 15 miles in to the East, and affords good anchorage throughout in 11 to 23 fathoms, mud and sand. The usual anchorage is in 11 to 6 fathoms, mud, off the town. Here coal, water, and other supplies may be obtained, and small repairs can be executed at a good foundry. Vessels having lost their anchors may run aground on the mud at the head of the bay.

The Coast of PORTUGAL is varied with rocky prominences falling away into low sandy bays. Its harbours universally require the aid of pilots; such are Vianna, Oporto, Aveiro, and even Lisbon.

Leixoes Harbour, a fine spacious artificial harbour 2¼ miles northward of the bar of the Douro, has lately been constructed and opened to shipping. Vessels unable to cross the dangerous bar of the Douro, can thus gain shelter here, instead of anchoring in the open roadstead. Over a large part of it the depths are 5 and 6 fathoms at low water.

Oporto is a busy city, picturesquely situated on the North bank of the *River Douro,* about 2 miles from the sea, and containing over 100,000 inhabitants. Fresh water, coal, and all kinds of supplies are plentiful here, but the great drawback is the difficulty of crossing the Douro bar; the pilots, however, are skilful. Vessels drawing 17 ft. can cross it at high water neaps, and a vessel drawing as much as 20 ft. has entered the port. The roadstead has depths of 10 to 14 fathoms, and is unsafe with winds from West to S.W. Vessels have sometimes been detained here for weeks, by the impassable condition of the bar, which is in its worst state from November until May.

From hence to the Tagus there is no harbour or anchorage available for large vessels. In passing along this coast in thick weather at night, beware of the current described on pages 316—317, and beware of mistaking the peninsula of Peniche for Burling Island, whereby vessels have been wrecked on the isthmus, notwithstanding the lighthouses marking this locality.*

Cape Roca, or the *Rock of Lisbon,* is the westernmost point of Europe; it forms the western extremity of the *Cintra Mountains,* and rises to an elevation of 550 ft., with a lighthouse on its summit.

The RIVER TAGUS is navigable for the largest vessels up to the city of Lisbon, about 7 miles from its entrance, but the approach is barred by the dangerous *Cachopo Shoals,* between which is a channel with 6 or 7 fathoms at low water springs. In S.W. gales, the sea breaks completely across, rendering the bar impracticable. There is good anchorage in *Cascaes Bay* in summer, but southerly winds throw in a sea which renders it untenable. Pilots are usually cruising off the bar, but they may always be obtained at Cascaes.

A stranger should not attempt to cross the bar in a sailing vessel, lest the winds fall calm, and the strength of the current set him on the banks, where the powerful operation of the tides has caused the destruction of many ships. Off the city the ebb runs down at the rate of 7 knots, and the danger in entering is when a strong ebb is running down, opposed to a strong wind from the sea, which makes a complete break, sometimes all over the bar. Under these circumstances a vessel is almost unmanageable, and the tide may sheer her about; but in the middle of the South Channel, the principal channel into the river, the tide sets directly through. To enter the river with a sailing vessel, during the ebb, would require a brisk gale and all sails set, in order to make any way, or even to stem the current; and it is to be observed, that within the river the wind comes very irregularly through the valleys on each side, unless it proceeds from the West or S.W. It is, however, tolerably steady when in the direction of the river.

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* *Meteorological Signals.*—The Portuguese Government has established stations at Nossa Senhora da Luz (River Douro), Cape Carvoeiro, Oitavos (River Tagus), Cape Espichel, and Sagres Point (near Cape St. Vincent). Passing vessels can here obtain information as to the state of the weather in the Bay of Biscay, Strait of Gibraltar, and at Madeira, the signals indicating the weather existing at 7^h a.m., either on the same day or the previous day, according to the time at which the signal is made, either after or before noon. The International Code flags, or the Semaphore, are used.

The marks for crossing the bar, in entering by the South Channel, are the Paps in line with Jacob's Ladder, or three beacons at the latter in line, bearing E.N.E. At night, *two red* lights near Caxias, in line, bearing N.E. by E. ¾ E., lead in. Having passed between Forts Bugio and St. Julian, proceed up the river in mid-channel, or as convenient, and anchor off the city in depths of 10 to 16 fathoms, mud. It is high water at Belem, on full and change, at $2^h\ 30^m$; springs rise 12 ft., neaps 9 feet.

Lisbon presents a fine appearance from the river, the Estrella dome towering above all the other buildings. Fine quays front the city all the way to the ancient castle of *Belem*, off which vessels entering are boarded by the customs and other officers. Supplies of all kinds, including coal, are abundant, but care is necessary as to the quality of the fresh water. There are facilities for the repair of vessels and their machinery, including dry docks, and further improvements are in contemplation.

Setubal Harbour, formed by the estuary of the *River Sado*, is much encumbered by shallow sandy flats, and the bar has 25 ft. over it at high water springs. Inside there is good anchorage in 5 to 8 fathoms, off the town. Wooden vessels are built and repaired here, and supplies of various kinds can be obtained, including coal in small quantities.

CAPE ST. VINCENT is about 200 ft. high, bluff and level, and on it is a convent where a *bright light* is shown, *revolving* every two minutes. About 50 yards off the cape is a high isolated rock, and the surf hereabout may sometimes be heard to a surprising distance. Soundings extend to a considerable distance from Cape St. Vincent, and to the southward of it fishing-boats may frequently be seen at anchor, fishing about 8 miles off shore. Dense fogs are frequent in this locality.

Gorringe or Gettysburg Bank, lying between Cape St. Vincent and the island of Madeira, at less than one-third of the distance from the former, is described later on.

Huelva is a mining town situated on the *River Odiel*, exporting large quantities of copper ore. Supplies may be obtained here, including coal. The estuary of the Rivers Odiel and Tinto is fronted by extensive shallow banks, and the bar of the *Canal del Padre Santo* is situated between the eastern extremity of these banks and that lining the shore. Vessels drawing 20 ft. can cross the bar in fine weather, but the aid of a pilot is necessary. Vessels anchor off Huelva in 17 to 22 ft. at low water, or they can lie alongside the piers.

Seville, about 70 miles up the *River Guadalquivir*, has been reached by a vessel drawing 18 ft., but owing to the bends in the river it is not safe for vessels over 230 ft. long, and in 1893 was only safe for vessels drawing 15½ ft. and under. *San Lucar de Barrameda*, at the entrance of the river, is a town of little importance. Owing to the shallow banks the aid of a pilot is necessary in entering. Vessels drawing 17 ft. can enter at ordinary high tides, and if waiting for tide or a pilot, can anchor in 7 to 5 fathoms, in fine weather.

It is recommended that no sailing ship taking the bar of San Lucar should attempt it on the ebb tide, especially if there are freshes in the river, because, with a broken sea and strong tide, a vessel may sheer on shore before she could recover herself.

Cadiz Bay, though extensive, is obstructed by several rocky banks, which renders Cadiz almost unapproachable. This city has a fine appearance from sea, and vessels can here obtain supplies of all kinds, including coal, but water has to be brought in tank vessels from Santa Maria. In the southern part of the bay are the docks, where repairs of all descriptions can be executed. The largest dry dock is 558 ft. long, with a depth of 24¼ ft. over the sill at high water. If necessary, vessels can anchor in 10 or 11 fathoms, about 2¼ miles N.N.W. of San Sebastian lighthouse. Vessels cannot depend upon finding pilots off the port at night.

CAPE TRAFALGAR, by the ancients called the *Promontory of Juno*, is 25 miles S. by E. ¼ E. from Cadiz; its appearance is low and flat, distinguished by a white building, and a lighthouse showing a *revolving bright* light every half minute. Off it lie some dangerous rocky shoals.

We have thus concluded the enumeration of the chief ports, &c., of the southern shores of England and Ireland, and of the northern and western coasts of France, Spain, and Portugal, for which, and the complete coasts, full descriptions and directions are given in the Sailing Directions accompanying the Charts, rendering it quite unnecessary to repeat them here. What follows, however, is a complete account of the Coasts and Islands of the North Atlantic Ocean, which are not described in such Sailing Directions.

2.—THE WEST COAST OF AFRICA, FROM TANGIER TO CAPE MESURADO.

Before proceeding to give a description of this coast, it will be as well to consider its political aspect, as so much of this part of Africa is now under European domination, by various treaties and arrangements.

Morocco is considered to be bounded on the South by the Wadi Shibika or Draa, in lat. 28° 19′ N., and remains under native rule (or rather misrule). Its population is variously estimated at from 4,000,000 to 15,000,000, and under European administration its fertile land, rich fisheries, and mineral wealth, would render it of great importance, as in the days of the Romans. There are no harbours, in the strict sense of the word, along its Atlantic coast; all the ports are simply open bays, the "best havens in Barbary," according to the familiar proverb of the Mediterranean sailors, "being June, July, and August." The ports at present open to commerce are Tangier, Laraiche, Sla, Rabat, Dar el Beida, Mazagan, Saffi, and Mogador, whence wheat, barley, maize, oil, esparto, and hemp are exported in considerable quantities. Wheat, barley, and beans are usually harvested in May and June, and maize about the end of July.*

Santa Cruz de Ifni, in about lat. 29° 22½′ N., is a small district ceded by Morocco to Spain, in 1883, for the establishment of a fishing station.

Sahara Desert.—This coast extends from the Shibika to Senegal River, and is inhabited by wandering tribes of savage Moors and Arabs. In 1878, the North-West African Company established a trading station at Cape Juby, and now have certain rights over the coast between the Wadi Draa and Cape Bojador. Between Cape Bojador and South Cape Blanco the coast is claimed by Spain, and numerous settlements of Canarian fishermen have been made along it. Thence to the Senegal, the coast is claimed by France.

Senegambia.—This important French colony is bounded on the North by False Cape Blanco, and on the South by the northern boundary of Sierra Leone, between the Mellacoree and Great Scarcies Rivers, but the English colony of Gambia, and Portuguese Guinea, occupy parts of the intervening coast. The coast of Senegambia is divided into three distinct parts, the first comprising the Sahara coast between Cape Blanco and Portendick; *Senegal* proper, embracing the Senegal and Salum Rivers; and the *Rivières du Sud*, including all the coast between the Componi and Mellacoree Rivers. In 1887, the exports of Senegambia were valued at about £577,000, of which ground-nuts† and oleaginous seeds represented about £192,000; gum, £185,000; and the remainder consisted of caoutchouc, tobacco, hides, &c.‡

Gambia.—By a treaty between the English and French governments, in 1889, this English colony is bounded on the North by Jinnak Creek, and on the South by the San Pedro River. It includes Sandeng, on Vintang Creek, and a space of 10 kilométres (6·21 statute miles) from either bank of the river, up to and around Yarbatenda.

Portuguese Guinea.—By a treaty between Portugal and France, in 1887, the northern boundary of the Portuguese possessions is a line passing from Cape Roxo about midway between the Casamanze and Cacheo Rivers. The southern boundary is the *Casset* or *Cajet River*, in about lat. 10° 53′ N., Katak Island and Cassini River belonging to Portugal, and Tristão Islands to France. It thus embraces the Cacheo, Jeba, Rio Grande, and other smaller rivers, whence there is a small export of beeswax, ivory, palm-oil, &c.

Sierra Leone.—By treaty with France, in 1889, the northern boundary of this English colony is Mahala Creek, between the Mellacoree and

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* Those wishing to consult the best authorities on this country should refer to the valuable "Bibliography of Morocco," by Lieut.-Col. Sir R. L. Playfair, and Dr. R. Brown, in the Supplementary Papers of the Royal Geographical Society, vol. iii., part 3, 1893.

† The ground-nut (*arachis hypogea*), the *arachide* of the French, is rich in oil, which is largely used as a substitute or adulterant for olive oil, also in the manufacture of "butterine," soap, &c.

‡ A very complete account of Senegambia will be found in "Les Colonies Françaises Le Sénégal," Paris, 1889.

Great Scarcies River. Its southern boundary is the River Manoh or Manna, beyond which is the territory of *Liberia*. The Isles do Los are administered from Sierra Leone.

Caution.—The following notice, issued by the British Consul, must be borne in mind by all frequenting the coast of Morocco :—

In consequence of several boats' crews having landed from shipping of various nations, on the open coast of Marocco, or West Barbary, in search, it is supposed, of water or other provisions, the Moorish authorities are desirous that all persons be cautioned that it is not only against the law of this land, and against the sanitary regulations, to land on any part of this coast, in places where there is not a port for its reception; but that, in consequence of the strict injunctions given to the people of this country by their government to prevent any person whatever from setting foot on land, or approaching near to it on the open coast, the lives of those who infringe the laws in this respect are exposed to danger.

Commanders and masters of vessels should, therefore, not venture, upon any account, to land, or to allow any person under their care or orders to land, or approach within gun-shot of the coast, excepting within the well-known ports.*

The Western Coast of Morocco has much increased in importance in recent times, and, owing to the running of steamers regularly, a good trade has sprung up with Great Britain. The chief articles of export are grain, peas and beans, esparto grass, wool, hides, &c. The trade is increasing more with the northern ports, and that with Mogador, which was formerly the chief town, is not so important. The system of discharging the cargo into lighters, which can easily cross the dangerous bars, has much facilitated the commerce of the coast.

TANGIER BAY is 3 miles in width, between Malabata Point and Tangier Point, and its shores are surrounded by high land. Its western part is clear of danger, but rocks and foul ground line its eastern shore. About two-thirds of a mile inland, on the South side of the bay, is *Mount Direction*, a conical, high, and pleasant-looking hill, East of which is a lower hill, surmounted by a tower. A stream runs between these two hills, and falls into the sea near the ruins of *Tingis*.

The town of *Tangier*, containing about 30,000 inhabitants in 1894, stands on the sloping land on the western side of the bay, its white houses being enclosed within a wall. It is now a place of some importance in the export of oxen, eggs, grain, hides, woollen goods, &c., their value in 1892 amounting to £201,971. There are lines of steamers calling here regularly, and telegraph communication with Gibraltar. The great want of the port is a mole or pier, passengers and cargo being at present landed on the beach, where a considerable swell sets in with S.E. and easterly winds. Fresh water is scarce here, though water-works are proposed, and provisions can only be obtained in small quantities.

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* The danger, *even at the present day*, of falling into the hands of the Moors and Arabs, must not be lightly overlooked. In September, 1889, a Spanish barque drove ashore near Alhucemas, on the Mediterranean coast of Morocco; the natives at once attacked and pillaged the vessel, carrying off the crew as prisoners. Various tribes along the Morocco coast appear to be quite beyond the control of the Sultan. Their practice has been, when a ship is stranded, and the crew compelled to surrender, to take everything portable from the vessel, and then, if the sea do not dash it to pieces, they set fire to it, that it may not serve as a warning to other ships which may be so unfortunate as to follow the same course.

Reference has previously been made to this subject on pages 319—320.

Light.—A white tower, standing on the battery at the S.E. angle of the sea-wall, shows a *fixed* light, elevated 58 ft., and visible 5 miles or more. It shows *red* seaward, between N. by E. ½ E. and E. by N. ½ N., and *bright* thence over the roadstead. On the town wall is a broad black line, which is in line with the lighthouse when bearing W. by S. ½ S.

Small craft find shelter from northerly and N.W. winds, under the remains of the old mole extending 2 cables eastward over the rocks off Tangier Point. Vessels of any size can anchor anywhere in the middle of the bay, in 7½ fathoms, sand, good holding ground, with Mount Direction bearing S.S.W., but will be exposed to winds between N.W. and N.E. round by North. Care must be taken to avoid *Bourée Rock*, lying about half a mile off shore, with 3 ft. least water on it, from which Mount Direction bears S.W. ½ S., and Fort Arabi el Said E. ½ S. A depth of 2 fathoms extends about 150 yards S.E. and West of the rock, but 4 to 7 fathoms is found a short distance North and South of it. Cape Malabata in line with Europa Point, Gibraltar, leads clear of the shoal, and the anchorage, therefore, lies with Gibraltar open of the cape. Ships moor to the N.W. and S.E., with the longest cable to the N.W. There is broken coral all over the bay, and ships should never lie with more cable out than is sufficient to keep them from driving. Easterly or Levant winds cause a heavy swell to tumble into the bay.

If entering the bay with a gale from the eastward, shelter will be found in 8 or 10 fathoms, off a small beach about 1 mile southward of Malabata Point.

It is high water at Tangier, on full and change, at $1^h\ 42^m$; springs rise 8½ ft., neaps 5 feet. In the offing the flood sets to the westward, and the ebb to the eastward, turning in mid-channel at high and low water by the shore. Within the bay, at half-ebb, the stream runs from East to West.

CAPE SPARTEL, or Ras el Skukkar, the N.W. extremity of Africa, is so high as to be visible 45 or 50 miles in clear weather, the land within attaining an elevation of 1,068 feet. At its extremity is a black rocky mass, which, when seen at a distance from the North or South, appears like an islet. Around the West side of the cape, and at about one-third of the whole height from the summit, is a range of well-defined basaltic columns, appearing like a coronet. Between the cape and Tangier, the coast is backed by a chain of hills, but to the southward is a wide plain, on which rises an isolated conical hill, called the *Nipple.*

The Lighthouse stands half a mile eastward of the extremity of the cape, and is the first established on the coast of Morocco. It is a square white stone tower, 79 ft. high, in lat. 35° 47′ N., long. 5° 55½′ W., showing a *fixed bright* light, elevated 312 ft., and visible 20 miles. Near the lighthouse is a *Lloyd's Signal Station,* connected by telegraph with Europe.

The ground about the cape is foul, with some high rocks on it, steep-to, and vessels are advised not to approach too closely, as the currents sweep violently round it. About 3 miles N.W. of the cape a depth of 100 fathoms is found, increasing quickly to seaward; but southward of the cape the shore bank increases greatly in breadth. In *Spartel Bay*, half a mile South of the cape, small vessels find shelter from easterly winds, in 6 or 7 fathoms.

The following description of the coast, between the parallels of 35¾° and 28° (those of Cape Spartel and Cape Juby), we owe principally to the Surveys of Lieutenants W. Arlett, in the *Ætna*, and H. Kellett, in the *Raven*, cutter, 1835; and to the notices of Mr. T. J. Evans, H.M.S. *Dido*, 1838; later information being added from various sources, and the bearings corrected for variation since the date they were given. At the same time, it must be distinctly understood, that the charts of the coast described in this chapter are not to be absolutely relied on (see page 4).

Currents.—During five months (from March to August, 1835), the time occupied by the *Ætna* and *Raven* in the survey of the coast, a distance of 750 miles, no day passed in which the former was not at least twelve hours at anchor, usually at the distance of 4 to 5 miles from shore, and in positions well adapted for making observations on the currents, which were constantly attended to. Independently of this, the *Raven* was repeatedly sent to the distance of 20 and 30 miles from land; particularly when fixed and conspicuous objects afforded opportunities for ascertaining her exact position; by comparing which with that which should have been given by the course steered, the rate and direction of the current could be ascertained to a considerable degree of exactness.

From Cape Spartel, along the coast, to Arsila, and also to the distance of 7 or 8 miles from the shore, a regular tide was experienced, running parallel to the coast; but its strength was rather greater to the northward than to the southward. In this distance, at 15 miles from land, no tide or current was perceptible.

From Arsila, to the southward, a tide was still experienced, gradually diminishing in strength till its direction could not be ascertained. From the parallel of 34° 30′ N. to the distance of 20 miles in the offing, a steady southerly set was first experienced. This current, in the offing, continues invariably to follow the direction of the land; its velocity increasing or diminishing, from the rate of four-tenths to 1 mile an hour, according to the strength or duration of the north-easterly winds.

From Mogador to Cape Bojador, except in particular instances, the current continues invariably to run in the direction of the coast. Its greatest strength is usually at the distance of from 3 to 6 miles from the land, gradually decreasing on receding from it. Its average rate between 31½° and 28° N. is from one-half to three-quarters of a mile in the hour. At Cape Juby, probably from its stream being in some measure confined by the projecting cape, and perhaps by the Canary Islands (distant 56 miles), it increases its rate to 1¼ mile, but diminishes off Cape Bojador to 1 mile. It did not appear that this current was influenced by the wind, but near the shore a tide was generally perceived.—(See remarks on the Currents on pages 317—324.)

Winds, &c.—During winter North and N.N.E. winds prevail on this coast, with occasional gales from the westward frequently attended by fog. In summer, fresh winds prevail between N.N.W. and E.N.E., through North. Between November and March the heavy surf renders landing difficult; in summer, and with strong winds off the land, there is no great difficulty.

To the south-westward of Cape Spartel, as shown on the chart, there are regular soundings toward the shore, but there are no harbours of consequence; those which exist being nearly choked up with sand. On sailing along, the inland mountains may be seen at a great distance, covered with snow, even in April and May.

Jeremias Anchorage, 3½ miles S.W. of Cape Spartel, offers good shelter for sailing vessels prevented from entering the Mediterranean by strong easterly winds. At 1 mile off shore, a depth of 20 fathoms is found, sandy bottom, good holding ground; at half a mile off the depth is 7 fathoms. Vessels anchor southward of the line of Mount Nipple bearing E. ½ N. In 1872, H.M.S. *Vulture* anchored in 14 fathoms, with the solitary white marabout tower bearing S.E.

Between Cape Spartel and the town of Arsila, 19 miles to S.W. by S., the coast chiefly consists of a flat sandy and shingly beach, rising to a fine grazing country in the interior. All along this coast there is good anchorage, sheltered from easterly winds. The depths are regular, 10 to 15 fathoms, over a bottom of mud or sand, at 1 to 2 miles off shore. H.M.S. *Dido* anchored in the following positions in smooth water, and well sheltered from a strong Levanter, or easterly wind. In 15 fathoms, sand and small shells, Cape Spartel bearing N.E. ¾ N., and the town of Arsila, S. by W. ½ W., distant about 5 miles; the distance to the nearest shore was about 1½ mile, the soundings being very regular to a depth of 5 fathoms, at 2 cables from shore. Farther southward she anchored in 13 fathoms, coral rock, gravel, and sand, Cape Spartel bearing N.E. by N., and the centre of the town of Arsila, about South, distant about 2½ miles.*

Arsila, or *Arzilla*, is a small fortified town close to the shore. Close to the North of it are the ruins of a Portuguese fort, and date trees, which overtopped the walls, were growing in the court. On the wall fronting the sea, which is strengthened by three towers, twenty guns were mounted, and under the southern angle of the wall is a white-washed tomb. The country around is well wooded, and a quantity laid out in gardens. The population is supposed to exceed 600. About 13 miles inland, E. by S. ¾ S. from Arsila, is *Jebel Habib*, a range of mountains very conspicuous from the sea, the loftiest of which rises 3,000 ft. above the sea. *Jebel Hasan*, another peak in this range, 5 or 6 miles more to the northward, is 2,200 ft. high.

At 4 or 5 miles N.E. of Arsila is the *Wed el Ayasha*, a small river, barred across the entrance, but reported to flow sufficiently strong for a good supply of water; and the distance to roll the casks, the boat being anchored clear of the surf, not above 50 yards. The preceding remarks, however, and the caution given on page 612, must be borne in mind.

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* A boat from H.M.S. *Dido* effected a landing at the village of *Almadrones*, nearly midway between Cape Spartel and Arsila, but those of the crew who landed were speedily taken prisoners by the Moors.

A. *The Port.* *View of Laraiche.* B. *The Town.*

In the latitude of Arsila the bank extends 12 miles from the land, to the depth of 70 fathoms. Here is (or was) a mackarel fishery, carried on by Spanish and Portuguese feluccas.*

From Arsila the coast trends to the S.W., and at the distance of 4 miles the coast hills rise to the height of 734 feet. At 5 miles farther on is *Haffat el Beida*, a remarkable white cliff, in the shape of a wedge, which rises to 300 ft. above the sea, and presents the same form in all directions. It may be distinguished when 15 miles off; but the best mark for this part of the coast is *Jebel Sarsar* or the *Peak of Fas*, an isolated mountain, resembling a sugar-loaf, which lies 24 miles S.S.E. from Laraiche.

Between Arsila and Laraiche the ground is tolerably clean, but not very good, being coarse gravel, with 25 and 30 fathoms of water at from 1 to 3 miles from shore. Off Laraiche the depth decreases, and there is only 4 fathoms at 2 cables from shore. In sailing along this coast, care must be taken not to advance too near, unless it should be with a strong easterly wind; for sometimes in calm weather, there is here a heavy swell from the West or N.W., which would render it difficult to get off shore.

LARAICHE or El Araish, a picturesque but ruinous town, is situated on the steep southern point of the River *Al Khos*, which here meanders through a rich and fertile valley; *Al Khos* signifies *the bow; El Araiche* the *pleasure-garden*. It has a good appearance from seaward, having a large castle on the top of the hill, a lofty mosque, and several towers. In 1886, the population numbered about 4,000, three-fourths Mohammedans and one-fourth Jews. The chief exports are beans, birdseed, wool, peas, and barley, the total value in 1892 being estimated at £89,853. In that year 212 vessels entered here, with a combined tonnage of 68,156; steamers call regularly. Supplies are said to be abundant, and there is a fine spring of water on the northern shore, very convenient for shipping.

Vessels will find the best anchorage with the town bearing between South and S.S.E. Those intending to enter the river lie in 12 fathoms, sand, about 1 mile off shore, with Jebel Sarsar, appearing in the middle of the entrance, bearing S.S.E.; or in 10 fathoms, 1¼ mile N.W. by W. ½ W. from the North entrance point, a "pap" on which rises 204 ft. above the sea. Landing is nearly always difficult and dangerous.

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* The method of taking the fish was by three hooks fastened together: the fisherman threw a handful of salt or sand into the water, to which the fish rose, and were immediately jigged with great dexterity. They were cleaned and salted on the spot.

The mouth of the river, which appears very broad, is really very narrow at low water, and has then only 5 and 6 ft. water over the bar, but there is a rise and fall of 9 to 12 feet. Inside the water deepens to 24 ft., and vessels moor in the bend off the town. Vessels not drawing above 12 ft. water can pass over the bar during spring tides, the average depth of water being 13 ft., but these depths cannot be relied on. In the winter of 1889—1890, a succession of heavy westerly gales blocked up the entrance, and vessels bound in had to wait at Gibraltar till the bar was cleared by the rains.

Between Laraiche and Rabat, the sandy coast runs in an almost straight line for 77 miles S.W., with no place of importance between. *Old Mamora,* 20 miles S.W. of Laraiche, and nearly *true* West of Jebel Sarsar, may be known from sea by several white-washed tombs, the chief of which is that of *Muley Bu Selham,* on the North side of the outlet of a stream said to flow from a small lake. At 2 cables from the bar is a depth of 5 fathoms, gradually increasing to 34 fathoms at 2 miles from shore. The coast between Laraiche and this spot is for the most part about 300 ft. in height, reddish cliffs for the first 10 miles, then sand-hills partly covered with brushwood.

Depths of 20 to 29 fathoms are found off all this coast, at 1½ mile from shore, and you may anchor off the coast hence to Rabat. Sailing ships, in fact, must sometimes anchor here, during a calm, to avoid being drifted by the currents, which set to the southward, along the coast; and the velocity of which, especially at the full and change of the moon, is frequently from 1 to 2 miles an hour. At 15 miles S.W. of Old Mamora is *Arlett Shoal,* a rocky patch of 7½ fathoms, with a remarkable black rock on the coast bearing E.S.E., distant 1 mile.

Mehediya.—Between Old Mamora and *Mahedia,* or *New Mamora,* 39 miles to S.W., the coast is very clear, a little higher than the former, and readily known, being of white sand as far as about the middle of its declivity, while the upper part appears like cliffs. The town of Mehediya extends from the seashore to the top of the highest land, 456 ft., so that you may readily distinguish from the offing the walls of an old castle in the upper part of it. The *River Sebu,* on the South bank of which the town is situated, is impassable except for boats and rafts, but there is deeper water inside the bar. The water discolours the sea for a long way off the entrance, and breakers are reported to lie about 3 miles off, with 11 fathoms close-to, with the fort bearing E. by S. ¾ S.

In summer vessels can anchor off the entrance, 16 fathoms, mud, being found at 2 miles off shore, but S.W. winds render it unsafe in winter. Ships may anchor at 1½ mile off shore, in 12 or 14 fathoms, sandy ground; but when the wind blows from the offing, and sometimes in fair weather, the swell here is very great, as well as along the coast. The best anchorage is with the town bearing from S.E. by E. to S.E. by S.

Mehediya was formerly a place of some consequence, and is noted for the ruins of fountains, arches, &c. The town now contains only 300 to 400 inhabitants, chiefly inhospitable fishermen, who subsist by the sale of *shebbel*, an excellent fish, much like salmon, which is caught here in great abundance.

In the summer the wind generally prevails from N. by E. to N.E. along the coast. During winter, there is a blustering S.W. and S.S.W. wind; and, in this season, when it begins to chop about to the South or S.E., shipping must get off, for it then commonly shifts to the S.W. and W.S.W., with foul weather. When it changes to W.N.W. or N.W., the weather is likely to be clear.

Between Mehediya and Sla or Sali, 16 miles to S.W., the coast is rather low and wooded, with double land, very even, and a white sandy strand, therefore readily known. At about half-way the strand rises, and thence to Sla the shore consists of black and steep rugged rocks, with small hills.

SLA and RABAT.—The towns of Sla and Rabat are divided by the river called the *Abu Regreb*. *Sla*, or *Sali*, once the terror of the seas, so renowned for its rovers, whose daring exploits reached even to our own coasts; whose city and port were a constant scene of riot and bustle, and activity; is now ruined, still, and lifeless. The present town, built on a sandy point, extending to the sea, forming the north-eastern bank of the river, is surrounded by walls 30 ft. high, with square towers at every 50 paces. The mosques, arches, and fountains in the city show traces of beautiful sculpture, and of great antiquity, but the streets are narrow, and the houses sombre, like all Moorish towns. The population of Sla numbers about 10,000.

The river entrance is about 500 yards wide when full. The bar, about one-eighth of a mile outside the entrance, extends quite across, and dries at low water. At spring tides there was not much more than 6½ to 7½ ft. water over it, except in a narrow winding channel; in 1889 the banks were reported to have extended. In 1892, a vessel drawing 7½ ft. crossed it safely at neap tide. Spring tides rise 9 to 12 ft., but the bar is always dangerous, owing to the continual heavy surf. Landing is effected by means of special lighters, but goods are often damaged by water in crossing the bar. A steam-tug has been provided by the government for towing the lighters.

Rabat, on the S.W. side of the river, stands 50 or 60 ft. above its level, on banks of crumbling sandstone, crowned by a venerable and battlemented *Kasbah*, or citadel. A curtain of 500 yards, facing the sea, flanked by two circular batteries, and a small battery overlooking the river at the S.W. end of the town, form its sea defences. The town contains about 20,000 inhabitants, and at its S.E. end is a remarkable old tower, called the tower of Beni Hassan, forming the best seamark for this place. It is built of hewn stone, and is 180 ft. in height, by 35 or 36 ft. broad. At a short distance to the northward of it are the ruins of an ancient wall. The country in this neighbourhood is planted with vines, oranges, and cotton, of excellent quality, and walled orchards reach along the banks of the river. Ship-building is also carried on both at Sla and Rabat.

The trade of this port consists in the export of wool, goat-skins, &c., valued at £28,967 in 1892, while the imports were valued at £192,931. In that year, 98 vessels entered here, with a total tonnage of 57,510; steamers call regularly. Supplies of fresh beef, fowls, and vegetables can be obtained here, and fruit in its season.

The roadstead is dangerous for sailing vessels in winter. They may lie here in safety from April to September inclusive; but are not secure in the rest of the year, the wind then blowing from the southern quarter, and often obliging them to quit their moorings. The best anchorage is in 21 fathoms, mud, 2 miles off shore, with Hassan Tower just open northward of the town. In fine weather a steamer may anchor farther in, in 10 fathoms, 1¼ mile off shore. As a great number of anchors have been lost in the road, much attention must be paid to the cables. From the anchorage the water shoalens very gradually till close to the bar, where it suddenly decreases from 7 to 2 fathoms.

It is high water at Rabat, on full and change, at about $1^h\ 46^m$; spring tides rise from 9 to 12 feet.

Between Rabat and Cape Fedala, 33 miles to W. by S. ½ S., there is no danger beyond a quarter of a mile from shore; the soundings, to the 100-fathoms line, extend 20 miles or more from the land, increasing south-westward. From 162 fathoms, mud, 22 miles N.W. of Rabat, the water shoalens suddenly to 90 or 80 fathoms, between which depths and 60 fathoms it continues for many miles, sand and mud, decreasing to 30 fathoms at 3 miles from shore. The coast features vary slightly, consisting of two lines of barren and gently undulating hills, from 200 to 400 ft. in height, extending nearly parallel to the coast; the higher and more distant are from 4 to 6 miles from the sea, the nearer not more than a mile, sloping gradually to the beach, which is generally sandy, with occasional patches of rock.

At 7 miles S.W. ¾ W. from Hassan Tower is *Massa Tower*, 190 ft. high, nearly 2 miles inland. At 22 miles farther on is the small walled Arab town of *Mansuria* or *El Mansoria;* the tower of the mosque, 80 ft. high, stands 180 ft. above the sea, from which it is less than a mile distant, and may be visible at a distance of 18 miles. The coast here is iron-bound and rocky.

Cape Fedala, 5 miles West of Mansuria, is a projecting point, eastward of which small vessels may anchor in 5 or 6 fathoms, but very near the shore, off the village of *Fedala* or *Fidallah,* sheltered from westerly winds. The roadstead here is supposed to be the only one, with the exception of Agadir in the parallel of 30° 27′, wherein ships on the coast may ride in security during winter. At a short distance the cape has the appearance of an island. The village, three-quarters of a mile from the sea, is a walled square, of about 200 paces, enclosing a respectable mosque, the ruins of European merchants' houses, and an Arab encampment. It may, perhaps, contain 300 inhabitants—Moors, Arabs, and Jews.

Cape Dar el Beida, 13 miles W. by S. of Cape Fedala, is another projecting point, surrounded by rocky reefs extending nearly half a mile off, and farther off to the northward is a rocky bank of 6 fathoms. The cape should have a berth of 3 miles in passing.

DAR EL BEIDA, or **Casa Blanca** (both names meaning White House), 2 miles S.E. by E. from the cape, is a small walled town of about 10,000 inhabitants, on the beach, the coast here forming a cove, three-quarters of a mile deep, said to be well sheltered from westerly winds, with depths of 6 to 8 fathoms, sand. The towers of three mosques are conspicuous, and one is of considerable height. Around the town are many palm-trees and gardens, and water is abundant. This town, as well as Fedala, was built for the exportation of corn, for the storage of which large warehouses have been erected. The exports now consist chiefly of barley, beans, wool, peas, maize, and seed, valued at £461,530 in 1892. In that year 384 vessels entered here, with a total tonnage of 188,436. Steamers call here regularly. Provisions are stated to be plentiful and cheap, and at certain times immense quantities of mackarel are caught.

Light.—A *fixed* light, visible 7 miles, is shown from a warehouse here, but should not be relied on; it shows *bright* over the bay, and *red* over the West Reef, or westward of N.N.E.

In the bay between Cape Fedala and Dar el Beida the bottom is rocky in many parts, and the anchorage must be very unsafe for sailing vessels in winter, though it is stated to be good at 1½ or 2 miles from the shore, where there is 10 to 17 fathoms water. Near the town there are reefs extending more than a quarter of a mile from the shore, over which the surf is constantly breaking. Between the anchorage ground and the shore a good bottom is found; but in consequence of a strong current which sets in from the westward, you should anchor beyond its action.

Steamers may anchor in 10 fathoms, sand, with the centre of the town wall bearing S.S.W., distant about three-quarters of a mile; or in 6½ fathoms, hard sand, farther in.

The landing-place is a narrow passage about 40 yards wide, with a sandy bottom, with reefs on either side, over which the surf breaks in almost all weathers. In making for this entrance the shore boats, long before they approach, steer to windward, and afterwards shape their course for the inlet, aided by the current. Strong West or N.W. winds stop all communication with the shore.

For 2 miles W.S.W. of Cape Dar el Beida the coast is rocky, and then commences a sandy beach extending 34 miles W. ½ S. to *Azimur Point*. Two parallel ranges of hills border the coast, and on their slopes several white tombs may be seen. It should not be closely approached, as rocky shoals and breakers extend a considerable distance off in places.

Azimur or *Azamor*.—At Azimur Point the coast turns to the S.W., and at 3 miles distant is the entrance of a river named the *Morbega* or *Um er Rabia,* the bar of which is dangerous, and dry at low water. Depths of 8 to 10 fathoms are found for 3 miles off it, but the bottom being foul and rocky there is no safe anchorage. On a sand-hill, 120 ft. high, on the South side of the entrance, is the small town of Azimur. Its walls, crumbling to ruin, are tenanted by storks. The place is dull and lifeless; the streets narrow and dirty; but provisions, fish, vegetables, and fruit, were abundant and good. The population numbered about 1,000, including Jews, carrying on a considerable trade in wool, which is shipped from Mazagan. The inhabitants of the country around, who are of superior stature, are chiefly pastoral, possessing large flocks of sheep and goats, and mostly live in tents. Wood is scarce and dear.

Cape Mazagan, 11 miles W. by S. from Azimur Point, is a low rocky point, off which a reef extends more than 1 mile to the N.E., and a 4-fathoms patch lies three-quarters of a mile farther on. The cape should be given a berth of at least 2 miles.

MAZAGAN, or **Mazighan,** known to the Moors as *Burjah,* on the East side of the cape, is a small walled town or fortress, with four towers, one about 150 ft. high; in 1886 the population numbered 3,000. The exports consist chiefly of garbansos or chick-peas, beans, almonds, wool, and maize, the value in 1892 being estimated at £260,501. In that year 319 vessels visited the port, with a total tonnage of 153,217. Steamers call here regularly. Supplies of mutton, beef, fish, and vegetables may be obtained, but water is somewhat scarce, though there is an admirably constructed tank, which will contain several thousands of tons. Landing is difficult at low water, though it is easy after half-flood.

Cape Mazagan and its reef shelter small craft from westerly winds to some extent, though a heavy swell rolls in. In running for the anchorage, give the cape and its reef a wide berth, bringing a small mosque,* about 1¼ mile S.E. of the town, to bear S.W., and keep it so till the large tower in the town bears West, when alter course for this mark, which will lead to good anchorage in 6½ to 8 fathoms, mud, and sand, from 7½ cables to 1 mile from the town. At 3 miles off shore there is anchorage in 15 fathoms, sandy ground. The anchorage is a dangerous one during the winter, being exposed to northerly winds. The sands on the S.E. side of the bay are said to be of a shifting nature, and wrecks are not uncommon.

Between Cape Mazagan and Cape Blanco, 11½ miles to S.W. by W. ¼ W., the coast should not be approached nearer than 1½ mile, as scattered rocks lie off the shore, and the bottom is very uneven. The beach, in some places sandy, is generally lined with craggy rocks. A line of barren hills, 200 ft. high, slope to the beach along the whole distance, and terminate just to the northward of Cape Blanco in a low and dark but abrupt and rocky cliff. In case of necessity, a vessel could anchor about 5 miles off, in 35 or 36 fathoms, oazy ground, but the swell is almost always very great, and the current is very strong.

About 4 miles to the W.N.W. of Cape Blanco are the ruins of *Tett* or *Tid,* an ancient town, with a conspicuous tower, 128 ft. high, standing 148 ft. above the sea, which may be seen from a great distance. Two large tombs, kept whitewashed, stand on either side of it.

CAPE BLANCO (North), in lat. 33° 8′ N., long. 8° 36′ 15″ W., appears to be of white sandstone, and the lines of strata, white and red, rising parallel to the horizon for some distance, suddenly drop at nearly a right angle to the water, and the cliff on its southern side is 170 ft. high, appearing like a wall. In the bight to the southward, which is formed by the cape, anchorage might be found in summer.

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* In November, 1887, Capt. G. von Pott, of the Austrian cruiser *Albatros,* stated that he could not make out this mosque or tower.—*Annalen der Hydrographie,* 1888, pages 149—150.

At 19 miles north-westward of Cape Blanco there are soundings of 100 fathoms, fine sand, or gravel, gradually decreasing to 28 fathoms at 4 miles from the shore.

From Cape Blanco the coast runs in almost a straight line for 47 miles S.W. by W. ½ W. to Cape Cantin, and is backed by a range of hills. At 4 miles from Cape Blanco is a dark and rather projecting cliff, formerly represented as an islet, under the name of *Duksal*; and, at 2 miles farther on, the hills rise gradually from the beach to the height of 465 feet. At 4 miles farther on stands a black tower near some ruins. Nearly midway between this and Cape Cantin are the ruins of *El Walidieh* or *Woladia*, where it seems there was once a harbour. At some distance to the south-westward of these ruins, on the edge of the cliff, are those of two other towns, supposed to be *Eder* and *Teturia*.

At 4 miles north-eastward of Cape Cantin the land begins to decrease in height, but close to the cape rises in a hummock, on which appears a white patch like ruins.

Cape Cantin, or *Ras al Hudik* (Cape of Palm Groves), in lat. 32° 32′ 50″ N., is a steep headland, which rises precipitously to 211 ft. above the sea, and on its summit is a small sepulchre. A ledge of rocks projects 1½ mile from it. At 16 miles westward from the cape there are soundings of 100 fathoms, fine sand; this depth gradually decreases towards the cape, 17 fathoms being found at 3 miles off.

Between Cape Cantin and Cape Safi, 12½ miles to S. by W. ½ W., the coast is much higher than that previously described, and consists of one continued white cliff, with a sandy beach at its base; the cliff, rising gradually to Cape Safi, its southern projection, is there upwards of 500 ft. in height. Between these points, at the distance of 3 miles from shore, is said to be a rocky bank, having 30 to 40 fathoms over it, and at times abounding with fish.

SAFI, or Asafi.—*Cape Safi*, the North point of Safi Bay, has a conspicuous square tower and tomb on its southern part. Southward of the cape the coast forms a bight, and the cliffs decline to a ravine, the bed of a winter torrent. On the southern slope of this ravine, in lat. 32° 18′ N., and 2½ miles south-eastward of the cape, stands the ancient town of Safi, intolerably hot in summer, and, in winter, very disagreeable, as the waters from the neighbouring mountains, occasioned by the rains, discharge themselves through the main street into the sea.

The town is conspicuous from seaward, and contains about 6,000 inhabitants. It is surrounded by a wall 31 ft. high, with a ditch, and the tower of one mosque rises to an elevation of 209 feet. Fresh water is scarce, and procured from wells southward of the town. The country in the immediate vicinity appears sandy and barren; but the interior is fertile. The exports consist chiefly of wool, beans, barley, olive oil, skins, peas, and maize, their value in 1892 being estimated at £190,140. In that year 157 vessels visited the port, with a total tonnage of 80,062.

During the summer months, or from March to October, Safi Bay affords as good anchorage, and smoother water than any other on the coast, but is entirely exposed to westerly winds, and in winter, when the wind is from South or S.W., vessels are frequently obliged to make off to sea.

The bottom is of sand and mud, and there is generally a depth of about 15 fathoms at a mile from shore, shoaling gradually to 5 fathoms close to the rocky shoals lining the shore. In winter, vessels anchor 3 miles off the town, in 20 or 22 fathoms, gray and oazy sand, with the low tower on Cape Safi bearing about N.E.

In summer, vessels may anchor farther in the bay, the same tower bearing N. ½ W., and the high castle of the town E. by S., in 16 fathoms, mud and shells, three-quarters of a mile off shore. There is also anchorage farther in, for steamers. You may boldly run in to the summer roads by night, with the castle bearing E. by S. or East. The landing is always bad, owing to the swell.

If bound to Safi, from the northward, shape such a course as will lead sufficiently to the westward of Cape Cantin, in order to avoid the rocks about that cape. You may easily know on which side of Safi you are standing, as the land to the northward of the bay is high and uneven, and that to the southward of it is plain, even land.

From Safi to the mouth of the *Wadi Tansift*, or *River of Morocco*, the coast trends S.W. ¾ S., 17 miles, and presents, generally, a line of sandhills, 140 to 200 ft. high, which, in some places, terminate in low cliffs, and in others slope to the beach. Inland is a ridge of sandy-looking hills, covered with brushwood, the highest 650 ft. above the sea. There is a large tank on the shore, nearly midway between Safi and the Tansift. At 7 miles from Safi is *Sharf el Yahudi* (Jew's Cliff), a red cliff 280 ft. high.

The *Wadi Tansift*, though barred at its entrance, is of considerable size within. On the northern side of the entrance is an old castellated building, square and roofless, which was built for the use of travellers. In summer, the bar is entirely dry at low water.

From the Tansift the coast trends S.W. by W. ¼ W., 25½ miles, to *Point Hadid*, a low sandy point, forming a cove to the northward of it, and rocks extend half a mile from the beach. The coast, which from the Tansift is barren and uncultivated, and from 200 to 300 ft. in height, here assumes features of fertility. At 9 miles from the Tansift is the tomb of *Sidi Abdalla Betak*, and farther on are some other tombs, and the ruins of a town will be seen at the base of the lofty *Jebel Hadid* or *Iron Mountains*. These mountains vary from 1,700 to 2,300 ft. in height, and extend more than 20 miles East and West, forming a mass of high land. On the West peak, 8 miles eastward of Point Hadid, is the tomb of *Sidi Wasman*, at an elevation of 2,100 ft., forming a conspicuous landmark.

Between Point Hadid and Mogador, 12 miles to S.W. ½ S., the coast is a sandy beach; the inland prospect is here bounded by the *Botof Sandhills*, which extend parallel to the beach, at the distance of a mile. At 6 to 7 miles off this coast, and as far as Safi, depths of 20 to 25 fathoms are found, decreasing gradually to the shore, except off Point Hadid.

On approaching the land in the parallel of Mogador, the first remarkable feature which appears, is the craggy summit of *Mount Atlas*, covered with snow, and contrasting with the dark ridges of hills between it and the coast. To the northward the Jebel Hadid first appears like an island, and, as you draw nearer, the long range of sand-hills becomes visible; and, finally, the white towers of Mogador rise, as it were, from the water.

Soundings, in 100 fathoms, may be found at 23 miles from shore, when the water immediately becomes discoloured; the depth decreases very gradually, over a bottom of sand. Care is necessary in approaching Mogador, on account of the low situation of the town, and the haze which often overhangs the coast.

MOGADOR, Suerrah, or *Suirra,* founded in 1760, is built on a low flat desert of accumulating sand, which separates it from the cultivated country, and is defended from the encroachment of the sea by rocks, which extend from the northern to the southern gate, though, at spring tides, it is almost surrounded by water. There are two towns, or rather a citadel, and an outer walled town, together containing about 15,000 inhabitants in 1892, of whom about 5,500 are Jews. It has a beautiful appearance from seaward, being built of white stone, but the streets are narrow and dull.

Among the principal exports from Mogador are goat-skins, almonds, gums, olive oil, beeswax, ostrich feathers, and wool, valued at £235,864 in 1892. In that year, 111 vessels visited the port, with a total tonnage of 88,365. Several lines of steamers call here regularly.

There is an excellent market, where provisions of all sorts, including fish of many kinds, poultry, and game, are abundant and cheap; as are, also, fruit and vegetables. An aqueduct conveys excellent water from springs, 2 miles distant, to several large tanks in different parts of the town, and there is a watering-place near the landing-place, where boats can obtain water, at high tide, with great facility.

The climate of Mogador is mild and equable, without extremes of heat or cold, the sun's heat in summer being tempered by the strong northerly Trade Winds, which blow almost constantly then. The average summer shade temperature is 70° to 75° F., winter 60° to 65°.

Vessels of moderate size can enter the harbour, but large vessels lie in the outer road, which, during the winter, can scarcely be considered tenable; and even in summer, the strong N.E. winds which prevail cause a very disagreeable sea. A winter seldom passes but some ships are driven ashore by the S.W. winds; and this happens generally between the 8th of December and the 18th of January, the season called *Liali* by the Arabs, and the only period really dangerous for shipping in the roads. Consequently, on signs of coming bad weather, vessels should put to sea. A good berth is in 13 fathoms, dark sand, three-quarters of a mile off shore, with the fort West of the custom-house bearing S.E. by E. At 1¼ mile off there are depths of 17 to 20 fathoms. A good anchorage for small vessels is in 3½ fathoms, sand and mud, with the North extreme of the rocks off the North end of Mogador Island bearing W. by N. ½ N., and the Custom-house, N. ¾ E., distant about 4½ cables.

Mogador Harbour is formed by a bight in the coast, on the South side of the town, somewhat sheltered from the westward by *Mogador Island.* This island, about 1½ mile in circumference and 94 ft. high, lies three-quarters of a mile S.W. of the town, on the extremity of a flat extending from the coast; it is almost surrounded by islets and reefs, which extend 3½ cables off its S.W. side. Opinions differ as to the safety of the harbour in winter. A westerly wind throws in a very heavy swell, but it is not generally considered unsafe for vessels properly found in cables and anchors. "A steamvessel may always consider herself safe, taking the precaution, if she is inside, to have two anchors down, one N.W., the other S.W., and having the engines ready to assist the cables."[*]

Others, however, recommend that on the first symptoms of more than an ordinary swell setting in, especially with a falling barometer, vessels should leave at once and seek an offing, for in moderate weather a swell sometimes breaks heavily across the entrance, making it difficult to get out, even with the aid of steam.

Depths of 3 to 5 fathoms are found in the harbour, the bottom sand over rock; but the usual anchorage is in 14 or 15 ft., close to the middle of the island. Vessels discharging cargo often lie in the N.E. part of the harbour, sheltered by the rocks extending off the town.[†]

The North Channel, that chiefly used, is 2½ cables wide between the reefs bordering the town and the island, with depths of 4 to 6 fathoms in it. To enter, keep in mid-channel; or the sanctuary of Sidi Mogodol, 1¼ mile southward of the town, bearing S.E. by S., leads safely through.

The South Channel is half a mile wide, but not used by vessels of more than 12 ft. draught, and it is said to be shoaling. Sailing vessels will find it convenient for leaving the harbour, as the current sets out by this channel. Keep about mid-channel.

It is high water, on full and change, at $1^h 18^m$; springs rise 10 or 12 ft., but the tidal stream is always weak.

Ras Tegriwelt or *Tagrifelt*, or *Cape Sem*, 8 miles S.W. of Mogador, is a low sandy point, sloping gradually from the height of 490 ft., and terminating in a reef of rocks which extend, on all sides, to the distance of rather more than two-thirds of a mile. The coast between this and Mogador is a continuous line of bare sand-hills, 70 ft. high, and sloping to the beach, and in the background are the *Botof Sandhills*, covered with dark evergreens. The ground off the cape is rocky, and a depth of 13 fathoms is found at 3 miles off shore. At 10 or 12 miles off the depths are 35 and 40 fathoms, oazy sand. Hereabout the current sets violently to the southward.

At 7½ miles S. ½ W. from Ras Tegriwelt is *Kuleihat*, a small village on the side of a wooded hill; a little stream, the *Tidsi*, falls into the sea at its foot, through a picturesque ravine, and between this and Cape Tefelneh, 10 miles to S.W. by S. ½ S., high cliffs, apparently of sandstone, face the sea.

Cape Tefelneh rises to the height of 700 ft., and terminates in a point from which a ledge of rocks extends half a mile, with deep water close to them. There is anchorage southward of it, in 10 fathoms, sand, affording shelter from East and N.E. winds. About 7 miles inland, between the Tidsi and Cape Tefelneh, is a range of mountains, attaining an elevation of 2,895 ft. at the southern end. From the North side of the cape a reef extends some distance out to sea, and should not be approached nearer than in 20 fathoms of water.

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[*] "Anuario de Madrid," 1865.

[†] *Caution.*—In July, 1887, the French steamer *Vérité* was burnt and sank in 4 fathoms at low water, forming a dangerous obstacle in the anchorage. She lies E. by N. ½ N. from the mosque on Mogador Island, and 4½ cables S. ½ E. from the ruined fort on the North side of the harbour. Up to the present time (1894), no attempt has been made to remove this danger, and the *buoy* marking it sometimes gets adrift.

CAPE GHIR or Geer, properly *Ras Aferni*, projects boldly into the sea at 28 miles S.S.W. of Cape Tefelneh. The coast between is hilly, with a sandy beach, and inland rises to the height of nearly 3,000 ft. above the sea; the country appears wooded, and numerous villages and tombs may be seen. On approaching Cape Ghir from the westward, it presents a remarkable bold bluff, sloping on each side, the highest part 1,235 ft. above the sea. To the northward of the cape, about 4 miles inland, stands a round hummock, which is a mark for the cape, and the land farther to the northward is still higher.

Towards Cape Ghir the bank of soundings gradually diminishes in breadth from the northward, the 100-fathoms line passing about 8 miles westward of the cape.

Between Cape Ghir and Agadir, 17 miles to S.E. by S., the coast forms a deep bay, offering convenient anchorage during north-easterly winds. High barren hills slope to the beach, which is rocky, to the distance of 5 miles N.W. of Agadir, where a streamlet, the *Wad Tamarect*, flowing through a green valley, discharges itself into the sea. The mountains inland are usually called the *Heights of Idantenan*, and form the western extremity of the main chain of the *Atlas*, which ranges hence in an E.N.E. direction, attaining in the interior an elevation of 10,000 to 12,000 feet.* One of these mountains, at 14 miles eastward of Cape Ghir, rises to the height of 4,400 ft., and at 8 miles N.E. by E. from Agadir is a remarkable conical hill, 3,800 ft. high. At 6 or 7 miles to the N.W. of Agadir, above a point stretching into the bay, is a good anchoring place, with depths of 12 to 20 fathoms.

AGADIR or Santa Cruz, the southernmost coast town of Morocco, stands on the summit of a hill 600 ft. high, and at its foot are a fishing village, and the ruins of the Portuguese town of *Fonte*, where the arms of that nation are yet to be seen in a building erected over the spring. Owing to the jealousy of its government, Agadir has ceased to be a place of trade; yet it was formerly the centre of a very extensive commerce, whither the Arabs, and the people of Soudan, resorted to purchase merchandise for the markets of the interior of Africa; and caravans were constantly passing to and from Timbuctoo. In 1882, it was proposed to re-open this port to foreign commerce, but up to the present it remains closed.

Agadir Bay is considered as one of the best roadsteads on the coast of Morocco, being large and sheltered from north-easterly winds, but it is exposed to those from the westward. It abounds in fish, immense quantities of which are caught by the inhabitants of the town. There is convenient anchorage in 7 or 8 fathoms, with the castle bearing N.N.E., and about two-thirds of a mile off shore; or farther out, in 11 and 12 fathoms, sand. Provisions and water are plentiful.

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* For a complete description of the Atlas, see "Ergänzungsheft No. 103" to Petermann's "Mitteilungen," being a monograph by Dr. Paul Schnell, entitled "Das Marokkanische Atlasgebirge," 1892.

In sailing from Cape Ghir to Agadir, keep somewhat near the coast till near the town, because northerly winds are very prevalent here; and should you keep too far from shore, you may be forced to fetch it up again with difficulty. If coming in by night, approach no nearer than in 12 or 14 fathoms. Care must be taken to have your anchors ready; the small bower always to be laid out before the land-wind, and the others to seaward; the sheet-anchor must also be in readiness, and brought out to the S.W. in case of an approaching storm, which is soon perceived by the rising and swelling of the sea. It is likewise necessary to keep the foresail to the yard, in case you should happen to be driven from your anchors.

From Agadir southward the authority of Morocco lessens, and the Wedinoons, inhabiting the province of *Suse*, proudly boast their independence.

Immediately to the southward of Agadir, a very low and flat country commences, and extends thence 28 miles to S.W. by S. At 5 miles from Agadir is the mouth of the *Suse*, a fine river, rising at the base of the Atlas; but the bar is nearly or quite dry at low water, and at high tide cannot be passed by vessels drawing more than 4 or 5 feet.* From the Suse the coast southward continues sandy, and at 7 miles distant are the wells called *Suwanieh, Tomieh*, or the Seven Wells, off which is an open roadstead. On this parallel, about 30° 0½′, is a depth of 86 fathoms, dark sand, at 16 miles from shore; and 40 fathoms, sand and mud, at 5 miles from the same, decreasing thence gradually to the beach.

The *Wadi Messa*, about 19 miles from the Suse, has, likewise, a bar dry at low water, but may have 4 or 5 ft. over it at high water, spring tides.* At a short distance within, on the North side, is a village; and near the beach, on the South side of the entrance, is a castellated building.

From the Messa southward the beach still continues sandy, but verdant hills, approaching the sea, break off into cliffs, apparently of sandstone, about 100 ft. in height. In the interior is a ridge of high mountains, at 50 or 60 miles from the coast, and the country between appears wooded and well-cultivated, with many houses and farm buildings. *Cape Aguluh*, or *Agula*, is only a slight projection of the coast, in lat. 29° 49′. Immediately to the northward of the cape is a little sandy bay, and a valley, through which runs a small stream called the *Wadi Assa*. The village of Aguluh stand on a hill, about 1 mile inland.

At 12 miles S.W. of Aguluh, the features of the country again change; the hills become barren and abrupt, and form in successive ridges, gradually increasing in height till they join the line of distant mountains, which rise to the height of nearly 4,000 ft., and appear to be the S.W. extremity of an off-set of the Atlas. Farther to the S.W. the appearance of the inland country continues the same, but the coast changes to dark red cliffs, broken into coves, on the beaches of which boats may be seen; and there are many villages, but inhabited by people of perfidious character.

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* Previous to 1861, Mr. W. J. Elton, Vice-Consul at Mogador, stated that the depth in the mouths of the Suse and Messa was 2 ft. at low water, the tide rising 10 feet.

At 6 miles S.W. of Aguluh is the village of *Sidi Abu Nuar;* at 9 miles farther on is *Sidi Abu el Fadail; Garizim* is 5 miles beyond this, at the mouth of a small river.

Santa Cruz de Ifni.—At 13 miles beyond Garizim, in about lat. 29° 22½′ N., is the *Wadi Ifni,* where landing can be effected in fine weather; here is the village of *Idufker,* elevated 300 ft. above the sea, and near it is a conspicuous white tomb. In 1883, this district was ceded to Spain by Morocco, for the establishment of a fishing station. There is fairly good anchorage here, and the country around could support a considerable population. The caravan tracks, too, are not far distant.

On the South side of the Ifni, in lat. 29° 22′, is a remarkable white cliff, supposed to be of limestone, and described by Lieutenant Arlett as follows:—Its strata are extremely curved and irregular, and it forms a good mark for the coast; behind it, and standing alone, is a conical-shaped mountain, rising to the height of 3,900 feet. At 21 miles N.W. of the white cliff the depth is 105 fathoms, broken shells; outside this the bank drops very suddenly. On standing inshore the soundings decrease rapidly to 60 fathoms; at 5 miles from shore there is 28 to 24 fathoms, coarse sand; and the depth thence decreases more gradually to the beach. From the white cliff the country assumes a more rugged and barren appearance; the hills steep, with deep and narrow ravines; the coast, alternate hills and sandy bays, with rocky and rugged prominences.

Jorba or *Sok Ensara,* in about lat. 29° 14′, is a deep ravine, near which are the ruins of an ancient mole. *Wadi Guader* or *Reguala,* or *Port Assaka,* in lat. 29° 10′ N., is a small bay lying between two rocky points. Its sides are steep and barren, and at its head is a deep and narrow ravine, down which a slender stream finds its way to the sea. The water is deep, and the bottom clean to the beach; a landing may generally be effected in it, but it affords no shelter. A little to the North of it is the village of *Salmagat,* where there are some wells.

In lat. 29° 0′ the coast mountains terminate, and a sandy desert commences; here there is also a break in the coast, which seems to be the dry bed of a river, and is called by the Canarians *Rio de Playa Blanca* (White Beach River). Near its entrance is an isolated conical hill, and inland may be seen the *Table Mountains* of Cape Nun. Between this and Cape Nun the coast trends 29 miles to W. by S., its western part consisting of bold sandstone cliffs, with bare sand-downs in the interior.

CAPE NUN, Noon, or *Morretes,* in lat. 28° 45¾′ N., is a cliff of sandstone 170 ft. high; but owing to the cliffs for some distance on each side being of the same height, and the country inland a flat desert, it is difficult to make out the exact projection till very near it. The cape is steep-to, and clear of danger, the depth gradually increasing seaward. At 4 miles off it the depths are from 30 to 34 fathoms, bottom of reddish sand; at 12 miles, 49 fathoms, dark sand; and at 32 miles, 85 fathoms, coarse red sand; the water then deepens very suddenly. For a long distance, both to the northward and southward of the cape, as well as to seaward, the water is very much discoloured. It has a red tinge, and is so thick that the track of a ship is visible for a length of time. It is caused by the fine dust blown off the land, and by the muddy water of the rivers.

The *Fishery* carried on by the people of the Canaries commences near the parallel of Cape Nun, the fishermen seldom venturing to the northward, although fish are equally abundant, from their dread of the Moors, who, on that part of the coast, possess boats. From the cape to the Bank of Arguin, an extent of 600 miles, the inhabitants of the desert have no boats, and the fishermen frequently land, not only to procure water, but to barter their fish for wool and orchilla; on these occasions great precautions are taken, as atrocities have frequently been perpetrated on both sides.

This fishery could be made a great source of wealth, but little has so far been done to develop its resources. At present (1894) 50 to 80 boats find employment here, catching the sama or bream, chierna or cod, and other fish, which is salted and taken to the Canary Islands.

The River Nun, Akassa, *Assaka, Inoon,* or *Shleema,* is a large stream debouching about 5 miles S.W. of Cape Nun, but its entrance is closed by a sandbank. When well open, it may be recognised by two remarkable hills, which will then appear in the centre of the gap. They are conical; and on one of them, 325 ft. high, are some ruins, said to be those of a Spanish fortress.

Between the Nun and the Shibika, 35 miles to S.W. by W. ½ W., the coast is a continued sandstone cliff, off which the depths are moderate, affording secure anchorage between the months of March and October. At 3 miles off there is a regular depth of 20 fathoms, good ground.

At *Meano* or *Uina,* midway between the Nun and Shibika, is a rocky reef forming a harbour for boats, which enter by passing among the reefs, or between their South end and the shore.

To the N.E. of the Shibika will be seen a sandy table-land, about 800 ft. high, at 5 miles inland, showing just above the cliffs. On approaching, the table-land appears to break into detached hills, one of which, 950 ft. high, and more insulated than the others, serves to identify the river.

The River Shibika or Draa, which is also known as the *Nun* or *Akassa,* is considered to form the southern boundary of Morocco, being in about lat. 28° 19′ N. It is of considerable size, but like the Nun is closed by a bar, over both of which there appeared to be a depth sufficient for large boats. The Shibika is salt for 20 miles up, but there is a spring of fresh water on the left bank of the entrance. Inland, on the banks of the Shibika, is the town of *Nun* or *Wedinoon,* a kind of intermediate depôt for merchandize on its way to the Soudan, and for the produce of the Soudan going to Mogador. Gums and wax are produced here. These rivers might be utilised, in the event of trade being opened up here, but at present this coast is closed to commerce. In 1886, an attempt was made to trade with the Moors here, but the boat capsized, two of the crew were killed, and the remainder made prisoners.

The features of the coast adjacent to the mouth of each river are very similar, so that the latitude becomes the best guide to distinguish them. When approaching the Shibika, the table-land above described will help to identify it.

Between the Shibika and *Punta del Morro,* 29 miles to W. ½ S., the land has much the same appearance as to the N.E., the coast consisting of cliffs about 120 ft. high. For 18 miles farther it consists of a low sandy beach backed by sand-hills. From the Shibika to Cape Bojador is the district known as *Tekna,* and thence to the southward is the district of *Tiris.*

Porto Cansado, so named by the Portuguese, is a sort of lagoon, into which runs a stream named *Uider.* The entrance is half a mile wide, eastward of a low sandy spit, with 2 to 3 fathoms in the channel over the bar, but the sea breaks heavily across, and at times it is scarcely possible for boats to enter; the best time for crossing is said to be from low water to half-flood. June and July are the worst months for the surf. Within the harbour opens out, and the depth increases to 4 and 6 fathoms; near its head are the remains of an old fortress, embedded in the sand. Near the harbour is a conspicuous red sand-hill, but the only distinguishing mark is a table-hill, about 400 ft. high, lying to the S. by W. As a rule, the constant surf, and the particles of dust in the air, render the coast very indistinct.

From Porto Cansado the coast trends 35 miles W. ¾ N. to Cape Juby. At 7 miles from Porto Cansado, the cliff, from 90 to 100 ft. in height, again commences, and continues for about 12 miles. The cliff is of dark sandstone, and the bottom, being also of dark sand, gives a green appearance to the water. There is no beach, the sea breaking against the cliffs, on which it appears to be encroaching, and a flat desert extends inland as far as the eye can reach. Where the cliffs terminate, the land becomes broken into sand-hills partly covered with bushes, and so continues to Cape Juby.

Between Cape Nun and Cape Juby the bank of soundings becomes much wider, the 100-fathoms line extending as far as 47 miles off shore, shoaling rapidly to 50 fathoms, and then more gradually to the shore. The current here strikes the coast obliquely, instead of running parallel to it, as it does to the northward, and is considered to have been the cause of numerous wrecks. The prevailing N.W. swell also renders it almost impossible for a sailing vessel embayed there to work off.

CAPE JUBY is a low sandy point, but near its extremity is a hummock, covered with bushes, appearing like an islet at a distance. Here the coast turns abruptly to S.W., and forms some coves, off the points of which lie scattered rocks. A reef, uncovering at low water, extends about 1½ cable off Cape Juby. To the westward is an off-lying reef, drying 4 ft. at low water, its northern end being almost connected with the shore reef, but depths of 6 to 9 ft. are found eastward of its South end; this basin is said to be silting up, but by dredging, &c., could be formed into a good harbour. At 1 cable within the S.W. end of this reef, and nearly 1 mile West of the hummock on Cape Juby, is a substantial square stone fortress, rising to an elevation of 37 ft. above high water, forming a conspicuous landmark. This, and a large stone building on the opposite shore, belong to the North-West African Company, established here in 1880; the stone was brought from the Canary Islands. The landing place is on the eastern side of the fort, but communication is often rendered difficult or impossible by the surf. It is in lat. 27° 56′ 41″ N., long. 12° 56′ 5″ W.

In 1886, H.M.S. *Sylvia* anchored in 8 fathoms, sand and broken shells, with the fort bearing S.E., distant about 4 cables; from here the depth gradually increases to seaward. It is high water, on full and change, at noon; springs rise 10 feet. The current is stated to frequently run 6 knots an hour to the S.W. round Cape Juby; in 1881, the officers of H.M.S. *Espiègle* found it running between 2 and 3 knots.

Supplies are obtained from Lanzarote, with which communication is kept up by schooner. Fish is abundant and good.

This part of Africa was first visited by Mr. Donald Mackenzie in 1876, to examine the coast with the object of founding a commercial settlement, and ultimately of opening up a trade route to the Western Soudan. After examining some 200 miles of coast-line, he selected Cape Juby as the most suitable place for the settlement, it having the advantages of being within 60 miles of the Canaries, possessing a splendid climate, and also situated near the Wadi routes between Northern Africa and the interior. The settlement met with bitter opposition from Spain and Morocco—from Spain because, about 400 years ago, she had built a castle on this coast, and from Morocco because the latter feared that a settlement so near the southern frontier of that Empire would interfere with the slave traffic, and take away much of the Soudan trade. Spain, with the object of thwarting these operations, took possession of 500 miles of the coast-line southward of Cape Juby, but the natives killed many of the settlers who went there, and the project resulted, practically, in a complete failure.

Owing to this hostility the settlement for many years was far from flourishing, but it now appears to be making progress. A settlement, known as *Tarfaya*, protected by a wall, is now being made on the shore, opposite the fort, and here is a sandy beach, where the landing is good.

The Climate is healthy, and, from observations made in 1884 and 1885, the heat is found to be modified by the cool N.N.E. wind which prevails for eight months (March to October) out of the twelve. The shade temperature rarely exceeds 80°, except during the Harmattan. This blows from S.E. to N.N.E. off the land, and may be expected between October and February. From November to February, the winds are variable, but chiefly N.E. and N.E. by N.*

About 15 miles S.W. ¾ S. from Cape Juby, at the southern end of some cliffs, is the mouth or delta of a large river, the *Sagia el Hamra*. This, in the rainy season, is wide and deep, stretching far into the interior, and along its course some magnificent pasture land was found.

For 60 miles S.W. of this the coast consists chiefly of sandy beach, with a few patches of cliff, backed, at 4 or 5 miles inland, by the *Matillos* range of sand-hills, which do not rise above 250 feet. In lat. 26° 48′ commences a line of cliffs, extending 40 miles, or to within 3 miles of *False Cape Bojador*, which is low and sandy, with a reef extending about 1½ mile northward of it. At 6 miles N.W. ½ W. from this cape there is a bank on which a depth of 7½ fathoms has been found. At 25 miles W.S.W. of False Cape is Cape Bojador, and the coast between should not be closely approached, as rocks extend off it in places.

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* See a Paper, by Sir Joseph C. Lee, on "The North-West Coast of Africa," in the "Journal of the Manchester Geographical Society," 1886, pages 145—164.

Red Dust.—The tropical regions of the African coast, between Cape Bojador and Cape Blanco, present to contemplation the *Sahara*, considered as the most extensive desert on the globe.[*] It consists of inadhesive sands, which are driven about by the winds, and chiefly by those from N.E., by which they are disturbed and carried to an astonishing distance, sometimes falling on vessels hundreds of miles out to sea. This phenomenon is more amply discussed at the end of this work.

The Baron Roussin says, that the coast to the southward of Cape Bojador is similar to that of the desert to which it belongs. It is arid and sandy, the only signs of vegetation being a few small tufts of dried brambles, scattered promiscuously here and there. It presents no other variety than some flat downs of a tabular form, whose base can scarcely be seen at the distance of 3 miles from the beach. The nature of its soil is exclusively siliceous, being sand without any mixture whatever. The surface of this plain is so completely horizontal, that it actually appears to have been levelled. In some places on the coast it terminates in a steep cliff, and in others in a gentle descent toward the sea. The cliffs are streaked with horizontal beds of different shades, approaching to white; the lower ones being generally thinner, and of a more reddish cast than the upper.

To the northward of the parallel of 23° N., the sand is overspread with a crust of black earth, which, from its being nearly general, may be taken as its covering, and is of a tolerable thickness. This species of crust no doubt derives its consistency from the great humidity which it contracts during the rainy season, and the extreme heat to which it is again suddenly and constantly exposed. By the repeated shocks of the sea, huge masses of this black crust fall to the bottom of the cliffs, and relieve the sameness of the shore. They first resemble rocks on which the sea breaks, but their corners are soon worn away, and they present but a heap of sand. On the whole extent of the coast, as far as Cape Verde, there is not a single piece of rock or granite.

CAPE BOJADOR, so named by the Portuguese from its *projecting* character,[†] is in lat. 26° 7′ 2″ N., long. 14° 30′ 20″ W., by observations of the officers of H.M.S. *Sylvia* in 1886. It is not very remarkable. When seen from the northward, it presents a strand of red sand, having a gradual descent toward the sea; and between its western extremity, which is very low, and the cliff 70 ft. high, which immediately follows, is a small bay, with 9 to 14 fathoms in it, but the bottom is foul. It is also stated that the bay, on its South side, affords anchorage in 4 or 5 fathoms, and ships may anchor farther out, in 15 to 20 fathoms, within 3 miles of the shore, on a bottom of sand, broken shells, &c. The *Sylvia* anchored in 12½ fathoms, 5 cables W.N.W. of the cape, and found the current setting weakly to the southward.

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[*] For a very full and complete account of the Sahara, with numerous illustrations and maps, the reader is referred to "Le Sahara," by Dr. Henri Schirmer, published in Paris, 1893.

[†] Cape Bojador was the limit of Portuguese knowledge up to the year 1435. Beyond it was the "Sea of Darkness," which they feared to penetrate, but in the year named, Alfonso Gonçalves de Balday rounded it. See Major's "Life of Prince Henry the Navigator," pages 85, 133, &c.

From the northward, the depths near the coast increase gradually toward the parallel of the cape, the bottom throughout being of sand and broken shells, or of sand and gravel. At 6 miles to seaward there is 25 fathoms; and the sandy bottom becomes more general—a circumstance which is common to all the African coast. The 100-fathoms line is from 18 to 25 miles distant, but to the S.W. the bank of soundings greatly increases in breadth.

From Cape Bojador the coast trends about S.W. ½ S., 63 miles, to a very remarkable dark cliff, about 300 ft. high, named *Penha Grande* or *Great Rock*. As its height exceeds that of any spot in the vicinity, it may serve as a good landmark. Its summit is flat and arid; all its declivities are precipices of broken earth of a gray colour, which has fallen down. At a mile from the foot of the cliff, there is 26 fathoms, hard bottom, with gravel and broken shells. All the coast thus far presents, alternately, cliffs and sandy beaches; but more particularly the former. It is from 150 to 200 ft. in height; being flat at its summit. The land in the interior, on which brushwood is very scarce, is of a darkish colour.

As before stated, the Spaniards recently endeavoured to form fishing settlements along this coast, but with small success. At 20 miles southward of Cape Bojador is *Maluine Bank*, breaking at low water, and lying about 1 mile off shore. To the southward of this bank is the anchorage of *Pilones* or *Bumbalda*, in depths of 9 or 10 fathoms, sandy bottom, off some small streams.

Between Penha Grande and Durnford Point, 112 miles to S.W. ¾ W., the coast on all this extent presents one continued cliff, with the exception of two or three places, where it slopes to the sea; the cliff being about 150 ft. high. Frequently, at a short distance from the water's edge, between the cliff and the sandy rocks which here cover the beach, there is a chain of white sandy downs. The summit of the cliff is even and horizontal, interrupted only by some small flat downs, scarcely perceptible. The whole of the beach is continually washed by an exceedingly heavy surf, and there is no sign of vegetation on the whole coast. Excellent fish abound along it.

Garnet Head, 15 miles S.W. of Penha Grande, is a projecting cliff, southward of which is *Garnet*, *Gurnard*, or *Moro Bay*, in which there is no shelter. It is the *Angra dos Ruivos*, discovered by the Portuguese sent out by Prince Henry in 1435, and abounds with cod, bream, hake, and other kinds of fish. About 6 miles beyond the bay are seven small table-hills, called the *Seven Capes*, which constitute an excellent landmark. About 25 miles S.W. of Garnet Head is *Leven Head*, off which H.M.S. *Leven* found clean anchorage in 15 fathoms.

Between Leven Head and *Elbow Point* or *Punta Caballo*, 32 miles to S.W., the depth near the shore diminishes. At less than 2 miles off, 9 to 12 fathoms is found, and N.W. of Elbow Point 18 fathoms is found at 15 miles off.

On the parallel of 24° N., and immediately abreast of an interruption in the cliff, is a beach of white sand, about 3 miles in extent, at 6 miles beyond which is *Deception Cliff* or *Mount*, a good landmark at the northern end of the sandy peninsula, within which lies the Rio Ouro. This peninsula extends 21 miles S.W. ½ W. to Durnford Point, and in some parts the water of the Rio Ouro may be seen over it, appearing like a lake. The peninsula abounds with game. At 1 to 3 miles from the shore, the soundings vary from 16 to 8 fathoms, with a hard bottom and shells. On approaching the river, white sand will be found.

The RIO OURO, or *Gold River*, forms an extensive basin or lake, 4 to 6 miles in width, into the head of which a river debouches during the rainy season, but disappears altogether in dry weather. Its eastern shore consists of high bluffs, and along the sandy shore of the peninsula are occasional bluffs of moderate height. The surrounding country is sandy and sterile, destitute of fresh water, and occasionally visited by wandering tribes. This estuary abounds in fish, and offers good anchorage for vessels of moderate draught, completely sheltered from the prevailing N.E. winds, and much frequented by fishing schooners from the Canaries.

Durnford Point, on the West side of the entrance, is in lat. 23° 37′ 59″ N., long. 16° 0′ 20″ W., and between it and *Trevor Point* the entrance is 5 miles wide, but the navigable channel is contracted to about half a mile in width by a sandbank extending from the coast towards the peninsula. In 1881, the bar had 12 ft. over it at low water, and spring tides rise 8 ft.; it lies about 1¾ mile East of Durnford Point, and South of a long sandy spit projecting from the peninsula, but after crossing it the channel rapidly deepens, and leads into a fine basin about 2 miles in width between the banks, with depths of 6 to 13 fathoms. About 8 miles in there is another bar of 7 ft. water, between which and *Herne Island*, lying on the banks at the head of the estuary, there are depths of 4 to 11 fathoms.

On *Mudge Head*, about 5 miles within Durnford Point, is a small Spanish fort and factory, and a gunboat is usually stationed here. The garrison draw their supplies from the Canaries, and fresh water has to be procured from the mainland.

The commander of H.M.S. *Espiègle*, who visited the Rio Ouro in 1881, remarked that the general uniformity of the coast makes it exceedingly difficult when approaching the estuary of this river to ascertain the ship's position by the appearance of the land. The soundings are a good guide, and there does not appear to be any alteration of importance since the survey of 1820.

In anchoring near Durnford Point, it will be advisable not to approach it within 6 cables, as a shoal of 9 to 15 ft. water extends to the S.W. of it. Breakers are visible 2 miles S. by E. of the point, on the South side of the entrance. Good anchorage will be found in 6 or 7 fathoms, somewhat less than a mile from the point, and can be reached by coming in on an easterly course, which will lead clear of doubtful spots. This anchorage is sheltered from the prevailing N.E. winds. To anchor between Durnford Point and the bar, bring the former to bear N.W., and Sandy Point E.N.E., and anchor in about 5 fathoms. The spit can generally be traced by the broken water, but caution is necessary, as a strong tide runs to the eastward on the flood.

No mark can be given for crossing the bar, and vessels should not attempt to cross it without first buoying the channel.

It is high water here, on full and change, at noon; springs rise 8 or 9 feet, and the streams set East and West, about 2 miles an hour. Over the bar and shoals the tide runs with great velocity.

No particular current was observed off the Rio Ouro. At about 3 miles seaward from the entrance, the bottom is of sand and shells, with depths varying from 9 to 16½ fathoms.

From *Fisherman Point*, the southern point of the entrance to the Rio Ouro, the coast trends 25 miles S.W. ¼ W. to the northern point of Angra de Cintra. For the first 13 miles the coast is cliffy, and then succeed white sandy downs, mostly with flat summits. The middle portion of this extent of coast is fronted by a bank with 5 fathoms on its outer edge, 3 or 4 miles off shore, and 12 to 13 fathoms close to it. At its northern end the bottom is sand and shells; to the southward, fine sand; and on the bank itself, broken shells. Anchorage may be found along this coast, but the bottom, from being composed of siliceous sand, must be unfavourable for holding.

ANGRA de CINTRA, Cintra Bay, known to the fishermen as *Golfo*, is a spacious but apparently shallow bight, 15 miles in extent N.E. and S.W., by 3½ miles deep. It is sheltered, on the North, by a very low projecting sandy point or peninsula, which runs parallel to the coast, and has a reef projecting 3 miles from its southern extremity. The southern point is also low, with a similar reef extending to the N.N.E. Between these reefs the entrance is about 7 miles wide, and nearly midway between, but nearer the southern side, is a detached reef, which breaks in blowing weather, and has depths of 4½ to 7 fathoms outside it. In winter, the sea breaks in several places in the entrance of the bay.

Vessels can enter North or South of the detached reef, and on doubling the northern reef, in 7 to 9 fathoms, the bay is found to extend about 4 miles to the N.E., inside the sandy point which protects it. The depth in it is not great; at a mile inside it is only 4½ fathoms, sandy bottom. At a short distance from the beach, in the northern part of the bay, amongst a number of even downs, there is one somewhat elevated above the rest, extending parallel to the coast. From being flattened at its summit, and having its southern extremity peaked, it becomes remarkable. It is stated that water may be obtained by digging at its base.

The stillness which prevails in this part of the bay attracts a great number of fish, and it forms a harbour for the fishing vessels. All the coast from the Rio Ouro is well stocked with fish, and is frequented by small vessels from the Canary Islands, which catch and salt fish for the consumption of those islands.*

In the open bay it is stated that, at 2 miles from the beach, there are depths of 9 to 16 fathoms, the bottom of sand, mixed with gravel, shells, or mud, generally covering siliceous or flinty rock, of the same nature as the neighbouring coast. Toward the bottom of the bay the mud becomes thicker; and here the anchor would sink down into a bed of greenish clay, which is excellent holding ground.

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* The fishermen attract some few Arabs, or Moors, to the spot, who seem to have no fixed habitation. They belong to the "Tribe of Thieves," complete wanderers and vagabonds, composed of the discontented of the three tribes, which are scattered along the coast from Cape Bojador to the Senegal; they subsist exclusively on dried fish, and the plunder from wrecks, *which formerly were so frequent here.* No advantage can be derived from any communication with these poor and miserable people.

From Cintra Bay the coast trends 21 miles to S.W. by S.; the shore is low, but it gradually rises inland, and becomes a continued down of white sand. At 11 or 12 miles to the southward of the bay, in the interior, may be seen four or five small isolated sandy downs, which are rather higher than the adjacent ground, and may serve as a mark for this coast. These heights are called the *Downs of Cintra,* but they can only be seen within the distance of 12 to 15 miles. The coast then turns to the S.W. by W., for 17 miles, presenting alternately cliffs and sandy beaches, as far as the East point of St. Cyprian Bay.

ST. CYPRIAN BAY is 7½ miles in extent, East and West, by 2½ miles in depth, with soundings of 5 to 11 fathoms in it. At the head of the bay the shore is low, and the sea breaks violently on it. The eastern point is formed by a cliff, 150 ft. high, having a circular form toward the sea, with a flat top, and much resembling a fortification. The western side is also formed by a steep cliff, which, after extending 2½ miles to the westward, turns abruptly to the S.W., and forms Cape Barbas.

The bay, being open from N.E. to W.N.W., offers no shelter from the prevailing wind on this coast. In consequence of this, there is generally a heavy sea in it; and the anchorage off it, although on a bottom of sand and mud, in 10 to 20 fathoms, offers very little security, and should be resorted to only in cases of necessity. The abundance of fish in this bay frequently attracts the fishermen from the Canaries, who, seduced by the hope of being quickly laden, and the appearance of a moderate breeze, anchor too near the bottom of it. In this situation, if the wind freshens up, being equally incapable of beating out with their crazy vessels, or of riding out the heavy sea which sets in, they are sure to drive and be thrown up on the beach, where their crews lose their property and lives; or, which is not less deplorable, are robbed and detained in slavery by the Arabs.

Cape Barbas, in lat. 22° 20½′ N., is a projecting point, at 4 miles N.N.E. of which H.M.S. *Leven* found anchorage in 19 fathoms, fine green sand. From hence to *Galha Point,* 9 miles to S.W. by W. ½ W., the coast is formed by one almost uninterrupted cliff, about 80 ft. high, at the foot of which the sea breaks violently. At 1 mile from the beach there are depths of 9 to 12 fathoms, and at 2 miles as much as 17 fathoms; with a bottom of muddy sand, or sand and broken shells. At Galha Point the coast declines into white sandy downs, studded here and there with cliffs, and on its southern side is a rather remarkable little bay, with a shore of white sand, barred by a flat of banks and reefs, on which there is very little water. These reefs serve as a foundation for two islets or rocks, whose nature is similar to that of the coast.

Pedra da Galha or *Gall Rock,* the northernmost, lies about 2 miles W. by N. from Galha Point, and is about half a mile in circumference, rather higher on the northern than on the southern side. A shoal extends

1 mile to the eastward of it. The other rock, named *Virginie* by M. Roussin, lies 3 miles to S.S.W., and is about three times the size, with some sandy patches. Shoal water extends half a mile southward of it. At 1 mile westward of these islets 18 fathoms may be found, bottom of muddy sand. The depth increases to the southward, and the bottom becomes harder.

Off Galha Point the 100-fathoms line again approaches nearer to the coast, that depth being found at 30 miles off, rapidly shoaling to 50 fathoms, and then more gradually to the shore.

Between Galha Point and False Cape Blanco, 85 miles to S.W. by S. ½ S., the coast is nearly straight, and moderately high, presenting only a few indentations of a trifling depth. As far as Cape Corvoeiro it is one continued down, the whiteness of which becomes more vivid on proceeding to the southward. In some places it presents peaked cliffs, in others there is a gentle descent toward the sea, and the whole is devoid of vegetation. At less than 2 miles off this coast the depth varies from 4 to 9 fathoms, and the current in the offing sets along shore 1 mile an hour, but at a less rate farther seaward.

In *St. Ann Bay*, a slight indentation in lat. 21° 53′ N., is a shoal about 1 mile off shore, on which the sea breaks heavily, and on it lies the wreck of the French steamer *Condé*. Southward of this bay is a moderately high cliff, whose irregular summit forms a striking contrast with the uniform smoothness of the adjoining coast. The cliff is 5 miles in extent, after which the downs again commence. The most salient point of the cliff is *Cape Corvoeiro*, but it is not well defined, and is only remarkable from the breaks in the beach where it is situated.

Southward of Cape Corvoeiro the coast is formed of white and red sandy downs, assuming various shapes, alternately terminating at the water's edge in broken cliffs and low sandy beaches. It appears safe to approach, depths of 10 to 20 fathoms being found at 2 miles off, bottom of mud and sand. On approaching within 25 miles of Cape Blanco, the waters of Lévrier Bay may be seen over the intervening sandy peninsula. *False Cape Blanco*, in lat. 20° 51′ N., is a high sandy projection, sometimes mistaken for Cape Blanco, which is 5 miles to S. by E. ½ E. Near False Cape is a *flagstaff*, marking the southern limit of the territory claimed by Spain, the French colony of Senegambia embracing the coast to the southward.

West Bay, formed between False Cape and Cape Blanco, has a beach of white sand, interspersed with masses of cliffs, through one of which the sea has perforated a hole, resembling an arch. The anchorage in the bay, as well as on the whole coast from Cape Corvoeiro, is good; a bottom of muddy sand prevails throughout the bay, with depths varying from 9 to 12 fathoms, about 1 mile from the shore. Large vessels will here find shelter from the prevailing N.N.E. and N.W. winds, and landing may be effected in tolerably smooth water. In 1886, H.M.S. *Sylvia* found fair anchorage in 5½ fathoms, with a bluff, about half a mile eastward of False Cape Blanco, bearing N. by E. The Canarian fishermen prefer this anchorage to any in Lévrier Bay.

CAPE BLANCO, in lat. 20° 47′ N., long. 17° 2′ 50″ W. (according to observations on H.M.S. *Sylvia*), is the southernmost face of a white cliff, about 80 ft. high, rising vertically from a gentle slope which extends from its base to the sea. It forms the southern extremity of a peninsula, which is about 24 miles in length, and from 1½ to 6 miles in breadth, forming the western side of Lévrier Bay. Captain Sir Edward Belcher, who examined this coast in H.M.S. *Ætna*, states that the summit of this peninsula is composed of lines of sand-hills and rocky eminences, just what one would expect to find if the sea were to quit its position, and show us the bed over which it flows. In every position, where a bush or rocky islet is prominent, there, on its southern side, you will surely find its sand-hill—a proof of the prevalent winds, as well as an admirable model of the formation of shoals under water, and pointing out most perfectly the "steep-to" approaches to banks, past which rapid streams or currents flow, with their concomitant shallow tail, formed by dead water or eddies. With the exception of these newly formed and forming sand-hills, the whole surface is covered, in a *most extraordinary manner*, with shells, of all dimensions, and of the species generally found in the bay. These are loose, and some are more than 60 ft. above the level of the sea.

All this coast abounds with good fish, as cod, bream, soles, &c., also the best kind of turtle, the green kind. The Canarian fishermen, who frequent the coast, in schooners of 100 to 150 tons burden, state that a small quantity of drinkable water may be obtained by digging a little to the southward of False Cape Blanco. This spot is occasionally visited by some Arabs, against whom it is necessary to guard. Those of the fishermen whom Captain Belcher met with were courteous and communicative. The fish taken by the *Ætna* were porgy, mullet of several kinds, rock-cod, and red-snappers, probably called bream by former voyagers. Mussels and other shell-fish are very abundant at low water.*

A shoal spit projects a quarter of a mile south-westward of Cape Blanco, with 3 fathoms near its extremity, and some off-lying patches of 3½ and 4 fathoms. For 3 or 4 miles beyond these lie the *Bayadère Banks*, which occasionally break, but have not been closely examined; the least depth found on them was 3½ fathoms, with 8 to 10 fathoms close to, and there are heavy overfalls on the ebb.

It is high water at Cape Blanco, on full and change, at $11^h 46^m$; springs rise about 6 ft., but they have been known to rise 10 feet. Within a distance of 8 or 10 miles round the cape, and in Lévrier Bay, the tides run irregularly, the direction of the stream depending upon that of the coast. At 1½ mile southward of the cape the flood ran S.E., and the ebb W.S.W., both at the rate of 2½ knots an hour; they set fairly into and out of Lévrier Bay, about 1½ mile an hour. Northward of the cape they set up and down the coast, but close inshore the stream is considerably weaker than at 3 miles off, where its greatest influence may be expected.

The Spaniards affirm that there is no rainy season here, but strong northerly and north-easterly winds the whole year. In June and July they were North, N.N.E., and N.E. The highest temperature of the air in the shade was 75°, and of the water, 76°.

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* From an account by Captain Sir Edward Belcher, in the "Journal of the Royal Geographical Society," vol. ii., pages 299—303.

Levrier Bay, or *Greyhound Bay*, is about 22 miles in extent, North and South, by 17 miles wide at its entrance, from whence both shores converge gradually to its head. From 10 fathoms in its entrance the depth gradually decreases inward, with a bottom generally composed of soft mud, but there are numerous shifting banks and detached shoals, especially along the low sandy eastern shore, needing a careful attention to the lead. *Lévrier Banks*, with 2 fathoms least water, lie 1¼ mile to the East of Cape Blanco; the channel between is 1 mile wide, with depths of 7 to 16 fathoms, and here vessels find uneasy anchorage in 10 or 12 fathoms, about three-quarters of a mile N.E. of the cape, and the anchors are liable to drag.

Repose Bay, 4½ miles N.N.E. of Cape Blanco, is 4 miles wide between *Cansado* and *Flore Points*, with depths from 5 to 2 fathoms, but quite exposed to the prevailing N.E. and N.N.E. winds, with their accompanying irritating dust. The *Ætna* parted one of her chain cables here, and Lieut. Arlett considered that Lévrier Bay affords no convenient anchorage, West Bay being much more suitable.

At 6 miles N.N.E. of Flore Point is *Star Bay*, a sort of shallow lagoon, with depths of 4 to 5 fathoms in the approach. *Archimedes Bay*, the northern angle of Lévrier Bay, has depths of 3 fathoms and under.

Directions.—To make Cape Blanco, it is recommended to approach it on the parallel of 20° 52′, and when in 15 fathoms anchor if it be night or the weather be thick. If clear, and wishing to enter Lévrier Bay, give the cape a berth of 1 mile to avoid the spit extending S.W. of it, and when the eastern angle of the cliff comes fairly in view, haul in towards the steep sandy beach, not approaching it within the depth of 7 fathoms, and anchor as convenient. A sailing vessel bound in must not attempt to round the cape with an ebb tide.

Captain Belcher advised vessels beating up from the southward, against the prevailing N.E. winds, to stand off during the flood on the starboard tack, and inshore with the ebb, the latter setting northerly. When the cape is brought to bear E.S.E., the land may be steered for boldly.

ARGUIN BANK is the great sandy flat which extends off the coast southward of Cape Blanco and Lévrier Bay, covering an extent of about 90 miles, and reaching to the southward of Cape Mirik. Off its northern end, separated from Bayadère Banks by a channel 5 miles wide, with depths of 7 to 12 fathoms, are some detached patches of 3 to 3½ fathoms, the northernmost lying about 7 miles S.E. by S. from Cape Blanco. From hence the western edge of the bank trends to S.W. by S., as far as the parallel of 20° N., in 17° 10′ W., and then turns to S. by E. ½ E., past Cape Mirik. The bank is said to be constantly increasing, being of the same nature as the coast; the body of it is hard, and covered with broken shells. Its outer edge has been traced from numerous soundings, and should not be approached within the depth of 8 fathoms, as no vessel can run within this limit without risk; at a very short distance to the eastward of this depth, there is less than 4 fathoms. No particular part on the edge of this bank has been seen quite dry; but close to the breakers, which occur in many places, there is not more than 10 ft. water; and the shallows between them do not appear to have more.

In approaching from seaward, the soundings decrease gradually towards the edge of the bank, between its northern end and its N.W. extremity in 20° 7′ N., 40 fathoms being found 30 miles off. To the southward of this parallel the bottom becomes more uneven; and from the point where the *Medusa* was lost, in 1816, in lat. 19° 53′ 42″, long. 17° 0′ 35″ W., a still greater irregularity takes place, as will be seen by a reference to the chart.

Westward of the northern part of the bank, the nature of the ground is stated by Baron Roussin to have a very remarkable characteristic, which may prove of very great service to navigators. From the depth of 8 fathoms to that of 25 fathoms, to seaward, including an extent of more than 15 miles, the lead invariably brings up a mixture of sand and broken shells; and, in proportion to the proximity of the bank, the latter prevail. Beyond the depth of 25 fathoms, as far as that of 55 and 50 fathoms, the bottom is entirely of white sand. Hence it is evident, that by soundings, and a rough observation for latitude, the approximate distance from the bank may always be known.* Should less than 25 fathoms be found, with a bottom of sand and broken shells, you will be less than 15 miles from its edge; and in proportion as shells predominate in the soundings, you will be nearer to it, and should avoid getting to the eastward. Should you have more than 25 fathoms, with fine sand, you will be more than 15 miles from it. To the northward of the parallel of 20° 20′ N., this may be particularly depended on; to the southward of that limit, it is subject to some exceptions; but as in lat. 20° the bank takes a direction S. by E. ½ E., it becomes no longer dangerous, if a ship is kept on a wind in 20 to 25 fathoms, and soundings frequently taken. A strict attention to incessant sounding, when in the vicinity of this dangerous bank, is so indispensable as to need no further recommendation.

Currents.—It has been already shown, in pages 312—315, 321, and 323—324, that the prevailing currents set from North to South along the whole coast. Along the edge of the Bank of Arguin, as far as its western extremity, this direction is constant; and in the rainy season, should any deviation be experienced, it may be relied on to happen very seldom. One proof of this may be adduced. On July 13th, 1830, when the wreck of the *Medusa* was found by the brig *Argus*, after 13 days' absence from the frigate, it was abreast of Portandik, at 45 miles from the shore, a distance of 90 miles, and nearly on the meridian of the place where she was lost. It must, therefore, have driven at the rate of 7 miles per day along the coast.

The bank has not been examined closely, and very little is known about the coast which it borders, with the exception of Arguin Bay, of which a survey was made by French officers in 1888. *Cape St. Ann*, 22 miles S.E. ½ E. from Cape Blanco, is low with marshes around, and at 11 miles farther to S.E. by S. is *Arguin Point*, the western point of Arguin Bay, marked by a pyramid *beacon*.

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* On May 11th, 1889, soundings in 56 fathoms, bottom of black sand, were obtained from the steamer *Doric*, in lat. 18° 57′ N., long. 18° 15′ W., or about 104 miles W. ½ N. from Cape Mirik; by the colour of the water the bank appeared to extend a long way to the North and N.E. Soundings previously taken around this position vary between 1,200 and 1,600 fathoms, muddy bottom.

Arguin Bay is an indentation in the low sandy coast, about 6 miles in diameter, but nearly all occupied by shoal banks, with some islands in its centre. *Arguin Island* is over 3 miles long North and South, and on its N.E. side are some buildings erected by a French trading company, but now abandoned. The island is formed of a whitish rock, covered with shifting sands to the depth of 9 ft.; the South end rises to about 30 feet. It produces no wood, and grows only a small caustic shrub, but has excellent water, though of milky appearance; the wells or tanks are near the settlement.

The approaches from Lévrier Bay are shallow, and intricate, and were marked by buoys and beacons, but in 1890 most of them had disappeared. At the anchorage, eastward of the settlement, the tide runs 2½ to 3½ knots at springs. Between September and April, the prevailing winds were from N.E. to E.S.E., and fish was then very abundant.

Between Arguin Bay and Cape Mirik the coast has not been examined, approach being barred by shoals and sandbanks. About 20 miles N.N.E. of Cape Mirik there is a group of islands, of which *Tider* is the most important. Southward of these is the *River St. Jean*.

Cape Mirik is a very low sandy point, on which there is a small down in about lat. 19° 23′ N., long. 16° 32′ 30″ W. Here is a fishing station named *Mahambar*. It is surrounded by the southern part of the Bank of Arguin, and cannot be approached by large vessels within 6 to 9 miles.

Tanit Bay.—From Cape Mirik the coast trends S.E. by S. ½ S. for 27 miles, and then forms a complete elbow, turning to S. by W. It is all low, and presents a continued chain of small regular downs, composed of white sand, and interspersed with small bushes. To the northward of the bay, formed by the bend of the coast, some downs may be observed which are rather higher and more insulated than the rest. A few huts are seen near the beach, and in the dry season numerous parties of the thieving tribe (page 635) assemble here to catch and dry fish. Here also are the fishing stations named *El Mahara* and *Lenheijerat*. Two large pieces of water may be seen between the high downs, but whether these be fresh or salt is unknown; the latter seems most probable.

Angel Hillocks.—From the head of Tanit Bay the coast trends 23 miles S. by W., and then 12 miles S. ½ E., and consists of a very low flat of quick-sand, backed by sand-hills. At this distance are some downs, which are rather higher than the rest, and with some bushes on their surface; these downs are the Angel Hillocks, their summits being from 90 to 120 ft. above the sea, and they constitute a useful landmark.* They are divided into two groups; the summit of the northernmost, which is much smaller than the other, is studded with tufts of brushwood, while the southern, which is formed of eight or nine hummocks, is nearly bare; the latter, which is the higher, stands in about lat. 18° 29′ 30″ N., long. 16° 3′ W. To the southward, the coast gradually declines in height, when it soon falls into a uniform line of sand, scarcely above the level of the sea, with an occasional bush here and there.

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* In 1881, a wreck lying off these hillocks formed a conspicuous mark.

Angel Bank.—No part of this coast, southward from Cape Mirik, should be approached into a less depth than 8 fathoms, which will be found at from 5 to 11 miles off. By attending to this rule all dangers will be avoided, and, amongst others, a shoal which extends 3 miles from the coast, abreast of the northern part of the Angel Hillocks, from which it derives its name. On this bank there are regular soundings on a bottom of sand and broken shells, affording anchorage in case of necessity. A good place to anchor is in 4½ or 5 fathoms, 4 miles from the beach, with the hillocks bearing N.E. by E.

PORTENDICK, or Portandic.—About 10 miles S.S.W. of the Angel Hillocks, and slightly elevated above the beach, is (or was) a stunted palm, about 18 ft. high, the only one seen on the coast between Cape Bojador and the Senegal. About 2 miles S.S.W. of the palm is the village of Portendick, in lat. 18° 15′ N., long. 16° 6′ 47″ W., an assemblage of low huts, used by fishermen or traders who bring gum here for barter.

An assemblage of shoals, with 1¾ to 3 fathoms over them, lies off Portendick, and the roadstead is between them, with depths of 4 to 5 fathoms, sand and shells, at 1 to 1½ mile off shore. Vessels can also anchor in 4 fathoms, nearer to the village, and about 2 cables southward of the northern shoal. Due caution must be exercised in approaching, as the land cannot be seen from a greater distance than 9 miles. In coming from the northward, make the Angel Hillocks, and then run along shore, keeping in about 6 fathoms. About half a mile southward of the village is a high bush; if this can be made out, bring it to bear S.E. by E., and by keeping it so the vessel will safely pass between the shoals to the anchorage in the roadstead. It is high water, on full and change, at 10^h; springs rise 6 feet.

From Portendick the coast trends S.S.W. and then S.W. by S., for about 103 miles, to the Mosquito Marigot, and, like that to the northward, is low, interspersed with small bushes, and presents a continued sameness. In the whole extent the only remarkable objects are two downs of red sand, partly covered with brushwood, but discernible only at about 2 miles from the beach; one is in lat. 17° 25′ N., the other in 16° 55′ N. From the mast-head some sheets of water may be seen at the foot of these downs. At 6 miles to the southward of the latter the interior of the country becomes a little clothed with brushwood, and occasionally presents some level plains, but the coast remains uniformly barren. Southward of lat. 18°, regular soundings of 12 to 6 fathoms are found at 2 or 3 miles from the beach, over fine sand or mud, where vessels may anchor.

The Marigot (or Lagoon) **of Mosquitos,** in about lat. 16° 36½′ N., is 36 miles N.E. by N. ½ N. from the Isle of St. Louis, in the Senegal; and it communicates with the sea only when the rains have swollen the river. It then covers the bank at its entrance, which may be passed over by boats; but they must be prepared against the heavy surf. Its banks are covered with mangroves, and near its entrance are the huts of *Inguiagher*. This river is the northernmost branch of the Senegal.

SENEGAL RIVER.—To the southward of the Marigot, the delta of the Senegal is separated from the ocean by a sandy tongue, formed by small white downs, nearly bare, and gradually becoming lower toward their southern extremity. Within this the streams of the Senegal wash a number of small islands, on which a covering of thick bushes gives the country some appearance of fertility. The outer islands are known by the names of *Antelope* or *Gazelle Island*, *Griel Wood Island*, and *Thiong Island*, and at a very short distance southward of the latter is the *Isle of St. Louis*, on which the French settlement is situated.

Griel Wood Island, the central island, is distinguished by its bushes, among which are some trees higher than the rest, presenting a remarkable contrast to the barren desert coast, 600 miles in extent, which lies to the northward. Both to the northward and southward of this island the river may be distinctly seen from the mast-head, running between the island and the beach; and it is the surest mark for discovering the landing-place to the northward of the bar.

A vessel may run along this coast, at 2 miles from the beach, in from 7 to 12 fathoms, over an excellent bottom of thick green mud.

ST. LOUIS, the chief French settlement on the Senegal, contained about 20,000 inhabitants in 1892, and is situated on the island of the same name; in approaching from seaward its white buildings are conspicuous. The beach separating the Senegal from the sea is so narrow and low, abreast of the northern part of this island, that the town appears to stand on the sea-shore; and it is only on nearing it that the channel which separates them can be seen. About 8½ miles northward of St. Louis is the village of *N'Diago*, near the shore, where are some large warehouses with red roofs.

On passing near the coast, the Isle of St. Louis affords a very agreeable prospect. Government House forms the principal object in this perspective, and to its right and left extend the two parts of the town, the streets of which are well arranged. The woods which line the East bank of the river appear, at a distance, to belong to the isle, and give it a cheerful and rural aspect, but this illusion disappears on a nearer approach; for no place can be more arid, parched, or deprived of vegetation, than the Isle of St. Louis, the soil of which is nothing but a fine shifting sand, and the water here is brackish and unwholesome.

St. Louis Island is narrow, not much more than 1 mile in length, and is connected with *Sor Island*, to the eastward, by a bridge of boats 660 yards long. On the latter island is the suburb of *Bouetville*, the terminus of the railway from Dakar, 150 miles distant, with which there is also telegraphic communication. It was opened to traffic in 1885.

The chief articles of export are gum Arabic, ground-nuts (the *Arachis hypogea*, or *Arachide* of the French), and hides; gold-dust and ivory are sometimes exported, but in small quantities. Its chief importance arises from the fact of the river here being the inlet to the principal French colony on the coast. There is a dockyard for the use of the French flotilla stationed on the river, and coal is stored here in large quantities. Supplies of beef, mutton, poultry, wood, and water may be obtained at reasonable prices; the water is obtained from Lampsar, 15 miles distant, but it is brackish in the dry season. A submarine telegraph cable connects St. Louis with the island of Tenerife, whence other cables extend to Europe and Brasil.

Light.—A small *fixed bright* light, visible 6 miles, is shown on the Government House, and near it is a staff on which the depth of water on the bar is signalled. It is proposed to establish a more powerful light on the North point of the island.

Guet N'dar, or *Gattandar*, is a small Moorish village, consisting of huts on a sand-hill, defended by a battery, standing upon the strand, opposite the town of St. Louis. From this place a canoe is launched on the approach of a vessel.

There is anchorage in 9 to 10 fathoms, mud, with the Government House at St. Louis bearing S.E., and about 2 miles off shore, but vessels usually anchor farther southward, in 7 to 11 fathoms, according to the season, at 2 to 5 miles off the bar. A good berth is in about 8 or 9 fathoms, 2½ miles off shore, with the Government House bearing N.E. ½ N.; the pilots' semaphore (3¾ miles southward of St. Louis), N.E. by E. ¾ E.; and the village of Mouit near the bar, S.E. by S. The roadstead is stated to be rendered very inconvenient by the constant short sea.

If standing in for the land by night, heave the lead frequently, as you fall into soundings all at once, 50 fathoms being found about 15 miles off shore, and thence shoaling to 8 and 7 fathoms at 1½ mile from it.

Directions.—The mouth of the Senegal presents nothing remarkable when approaching from the northward. The breakers which prevail on the whole coast as far as *Point Barbary*, the northern point of the entrance, prevent those on the bar from being distinguished; and vessels may run past without seeing them, if they keep at too great a distance from the shore. From Guet N'dar you may run at the distance of a mile from the beach without danger; which will enable you to observe everything distinctly. At 1½ mile southward of the village is a signal staff, abreast of *English Islet;* at 2½ miles farther on is a guard-house on the South end of *Babagué Island.* This guard-house is a remarkable small square house, near which is the *Pilots' Semaphore;* a vessel may anchor when this guard-house bears E. ¾ S. At 3 miles southward of the semaphore is the *Ile aux Pilotes*, 33 ft. high, and at 1 mile farther southward is the telegraph station of *Marché de Gandiolle*, a conspicuous house with a red roof and white gables. As the winds generally blow from the northward, it is advisable to anchor rather to the northward than to the southward of the bar, to facilitate communication with the shore.

In running for the Senegal, from the southward, the mouth of the river was more easily distinguished than when approaching from the northward, from its appearing more open. At 35 miles S.W. by S. from St. Louis, and on the parallel of 15° 26′ N., the large red sandy down of *Tiakhmat* may be observed, entirely bare, which, to those ignorant of their latitude, may serve to indicate their distance to the southward of the bar. Near this sand-hill are some palms. To the southward of the bar, and about 12 miles from St. Louis, are the five *Musseguiob Sand-hills*, 16 to 29 ft. high, on one of which is a flagstaff.

The Bar of the Senegal is not stationary, being liable to great fluctuations, both in depth and position; consequently no description can be given which would be accurate for any length of time. Below St. Louis, the West bank of the river is so low that very high tides completely overflow it, and at times force open a new channel. In 1817, the channel was 6 miles southward of St. Louis. In April, 1873, it was 2 miles farther southward, and was divided into two channels by shoals, the North or navigable channel being about 87 yards wide, with 8 to 11 ft. water in it; the current ran at the rate of 2 knots with the flood, increasing to about 4 knots with the ebb.

In November, 1881, the channel was found to have shifted 2 miles farther southward, or 10 miles from St. Louis; in December, 1882, the depth in it was 9½ ft., but a vessel drawing 6 ft. bumped heavily in crossing it. According to the latest reports the entrance is now about 9 miles from St. Louis.

It is recommended that vessels crossing the bar should not draw more than 8½ ft. water; those drawing more than 10 ft. can rarely enter the river. Only vessels of a moderate size should be employed in the commercial navigation of these parts; otherwise the loading and unloading, when necessary to employ lighters, becomes expensive. Inside the bar the depth is from 4 to 7 fathoms: and, with the assistance of the tide and a pilot, a sailing vessel may very easily beat up to the Isle of St. Louis. If necessary, a steam-tug is available for towing vessels.

Signals.—When the bar can be safely crossed, a *yellow flag* is hoisted at the Pilot Station. A *blue flag* signifies that the bar is impracticable. A *yellow and blue flag* intimates that pilots are at the bar for vessels approaching.

It is high water, on full and change, at $8^h\ 42^m$, and at St. Louis at 10^h; springs rise 6½ feet.

The dangers attending the bar of the Senegal are well known to be of no trifling nature. In the rainy season, and even in March, when the river, increased by the rains, discharges a greater body of water into the sea, the bar is frequently impracticable even by decked boats. The waves, caused by the impetuosity of the river water meeting with that of the ocean, are very considerable, and succeed each other so rapidly that it is impossible to find a *smooth*. It is not uncommon, in these cases, to see breakers at the distance of a mile from the bar, and in 8 fathoms of water. From April to the end of September the bar may generally be crossed by decked boats, and sometimes even by canoes; but it is advisable that they should be steered by natives.

At times the waves are very remarkable. When the sea is but slightly agitated, one may perceive three waves, perfectly distinct, approach and break against the bar, immediately after each other; and these three waves appear to be, as it were, connected; for there is often a considerable interval of time between the attack of the first three waves and the approach of the succeeding trio.

The limits of navigation vary with the seasons. Vessels drawing 8 ft. can always reach the town of *Mafu*, about 168 miles above St. Louis; after the middle of July they could reach *Bakel*, 410 miles above St. Louis; and in August and September could ascend as far as *Khayes*, near *Medina*, or the first cataract, a distance of about 500 miles.* The river attains its lowest level in June, and is highest at Medina in August, and at St. Louis in October; the water sometimes rises 65 ft. at Medina, 49 ft. at Bakel, 23 to 29 ft. at Podor (260 miles above St. Louis), 16 to 20 ft. at Dagana (182 miles above St. Louis), but only 3 to 4½ ft. at St. Louis.†

Winds.—The winds are not at all dangerous in the navigation of the coasts of the Senegal. They blow between East and North during the greater part of the year; and as, in the rainy season (June to September), the squalls generally come from the S.E., those vessels in the road which cannot depend on their ground tackle can easily get under way, and return to their anchorage after the squall is over, as the S.W. winds which succeed are generally very weak. In the fine season, strong N.W. winds sometimes occur, but are of short duration. In the dry season, the sea breezes blow regularly, but the climate is then very unhealthy.

Currents.—It has already been said that the general and almost constant direction of the current is along the coast from North to South, as far as the mouth of the Senegal, but abreast of this opening, and in a space of several miles to seaward, the river tides affect the general uniformity of this current. The flood and ebb tides are alternately felt at the bar and anchorage; they have no settled direction, but may be considered as setting about N.W. and S.E.; and are frequently so strong as to make the vessels tend at the anchorage, or at least to lie with their broadsides to the wind, in the strongest breezes.

The Coast.—A straight line drawn from the bar of the Senegal to Almadi Point has a direction nearly S.W. by W. ¼ W., and a length of 86 miles. The arc described by the intervening coast, and subtended by this chord, bends so little, that it would not exceed the whole length by more than 12 miles, and its greatest depth would be about 10 miles. There are several villages along the coast.

As far as 8 or 10 miles southward of the Senegal, the coast is just as low as that to the northward, and resembles it very much; it afterward becomes rather higher, but is uniform in general appearance, a chain of white sandy downs, scattered over with brushwood, amongst which a small cluster of trees may be distinguished. It generally presents two well defined plains. The first is next to the sea, formed of white sandy downs, on which there appears some verdure. The second, which is considerably higher than the first, commences at about 2 miles in the interior, and is formed by downs of a greyish colour, which are covered with bushes. About 18 miles S.W. by S. from the bar are four red sand-hills known as *Tund* or *Mélèye*, off which is the anchorage of *Kelere*. At 8 miles farther on is *Tiakhmat Sand-hill*, previously mentioned on page 644.

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* A railway runs from Khayes as far as Bafoulabé, and thence the French propose to extend it to Bammaku on the River Niger.

† Full particulars of the Senegal will be found in the "Note sur la Navigabilité du Sénégal," by Lieut. G. Dorlodot-Dessart, in the "Révue Maritime et Coloniale," 1879, pages 502—513; also in "Le Sénégal," by General Faidherbe, 1889; and in "De St. Louis au Port de Tombouktou," by Lieut. E. Caron," 1891.

From these downs, southward, the coast presents nothing remarkable as far as the *Little Paps*, of which the northern is in lat. 14° 56′ 24″ N., long. 17° 8′ W. These are the two highest downs between the Senegal and the Paps of Cape Verde. They are situated on the beach, and are easily known by a slight undulation of their summit, and three or four other small hills adjoining them to the southward. They are of a dark colour, and visible at the distance of 12 or 15 miles; they bear about E. ¾ N., distant 27 miles, from those on Cape Verde, and when running this distance, in fine clear weather, it frequently happens that both may be discerned at one time, as the latter may be seen at the distance of 20 to 25 miles.

Yof Bay.—Westward of the Little Paps the coast rises very much, and becomes more wooded, forming between them and Cape Verde the slender bight known as Yof Bay. Landing is easy at *Cayar*, just westward of the Little Paps, but otherwise it is recommended not to approach the shore of the bay too closely, as the currents in it are said to be strong and irregular, especially with the flood stream and during the winter. Within a distance of 2 miles northward of the village of *Yof*, situated near an islet of that name, 3¼ miles eastward of Almadi Point, there is 55 fathoms water over a bottom of mud and sand.

Southward from the Senegal, as far as the parallel of 15° 20′ N., including an extent of about 35 miles, at 2 or 3 miles from the coast, the bottom is excellent, being of pure mud, with depths varying from 10 to 30 fathoms. From this parallel, to the southward, the depths increase considerably; at 6 to 8 miles N.W. by W. from the Little Paps, for instance, there is from 57 to 62 fathoms of water. The muddy bottom continues here, and is so soft that the lead sinks deep into it, affording anchorage for sailing vessels obliged to come-to owing to a calm. It is only in this case that anchoring becomes necessary; if there is wind from either quarter, the formation of the coast will always allow a favourable board to any vessel well found and well managed.

The prevailing currents between the Senegal and Cape Verde follow the direction of the coast, in the same manner as those to the northward; and the idea of a current setting violently into the Bay of Yof is by some stated to be altogether false. The sea on this part of the coast is not particularly heavy or dangerous; the smallest coasters of the Senegal and Goree expose themselves to it with impunity every day.

CAPE VERDE, the westernmost point of Africa, is the extremity of a peninsula formed on the North by the Bay of Yof, and on the South by the bay in which the Isles of Goree and Dakar are situated, and is composed of moderately high land. The country about the cape is covered with trees, amongst which are several of remarkable height. *Almadi Point*, the extreme western point of Cape Verde, is very low, but there are some detached hillocks on it, which, at a distance, may be taken for islets. It rises inland in two Paps, the S.W. shore of which is nearly perpendicular.

The Lighthouse, on the western Pap of Cape Verde, is a round white tower 66 ft. high, in lat. 14° 44′ 30″ N., long. 17° 31′ W.; the light is *revolving bright*, attaining its greatest brilliancy once every half-minute, at an elevation of 371 ft. above high water, and visible for a distance of 27 miles in clear weather.*

Near the lighthouse is a semaphore *Signal Station*, connected with Dakar by telegraph.

The Lighthouse on Almadi Point is a square white building 39 ft. high, 2 miles N.W. ½ W. from Cape Verde lighthouse. It shows a *fixed red* light, elevated 85 ft., and visible 8 miles.*

Almadi or N'giolma Ledge.—The western extremity of Almadi Point extends 1 mile still farther West, in a flat of blackish rocks, mostly awash, and which, in two or three places, rise from 8 to 10 ft. above the level of the sea; the highest and westernmost rock, which appears from a distance in the shape of a cube, is in lat. 14° 44′ 30″ N., long. 17° 33′ 30″ W. The sea breaks incessantly on these rocks, though amongst them are some smooth spots appearing like channels fit for boats.

This rocky flat may be coasted at the distance of a mile, there being, on the West, 35 fathoms of water, bottom of broken shells. Hence to the northward, in an extent of 3 miles, the depth increases to 70 and 80 fathoms, bottom of mud and sand. To the S.S.E. the depth is not so great; in running along these breakers and the coast, for a distance of 2 miles in that direction, which will extend to the meridian of the Paps, the depth varies from 25 to 39 fathoms, the bottom consisting of sand and shells, or sand and rock. The depth then continues to decrease to the E.S.E.

It is high water at Cape Verde, on full and change, at $7^h 45^m$; springs rise 3 feet. Near the cape the flood stream sets to the northward, and the ebb off shore.

From Almadi Point the western coast of the Cape Verde peninsula trends 8 miles S.E. by S. ¾ S. to Cape Manuel, its southern extremity. All this coast is high, covered with trees, and generally terminates at the shore in basaltic cliffs or sandy rocks. In some places only, the cliffs form small bays with beaches of white sand.

Cape Manuel, or *Baniul*, is high, formed of columns of basalt, and covered with very thick brushwood. It is steep-to, a depth of 10 fathoms being found at half a cable southward of it, and 5 fathoms at 1 cable S.E. of it; but at 1 cable north-westward of its extreme point is a small rock close to the beach. On rounding the cape the extensive bay of Goree is opened.

The Lighthouse on Cape Manuel is a square white building 39 ft. high, 6 miles S. by E. ¾ E. from Cape Verde lighthouse. It shows a *fixed red* light, elevated 171 ft., and visible 8 miles. To the northward of the lighthouse are the lazaretto buildings.

At 2 miles W.N.W. of Cape Manuel, and 1¼ mile off shore, is a group of four rocky islets, known as the *Magdalens*, *Madeleines*, or *Oures*. The sea breaks violently over the three smaller islets, but the northern islet is about 600 yards long, and rises to a height of 100 feet. It is nothing but a bare rock of reddish colour mixed with basalt, and perfectly destitute of any vegetation, though there were formerly some *baobabs*[*] growing in the crevices of the rocks. The shape of this islet is that of a crescent open to the westward, and on its North side is a gap, forming a very small creek, which affords a landing. The other three islets lie to the south-eastward of the principal islet, with depths of 3 to 6 fathoms in the channel between, and here the sea breaks.

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* In 1892, Cape Verde light was reported to be only visible 13 miles, and Almadi Point light, 5 or 6 miles.

The channel between Magdalen Islets and the main has depths of 3 to 4½ fathoms, but it should not be attempted by a stranger. Between Almadi Reef and Magdalen Islets, the soundings vary from 34 to 19 fathoms, at 2 miles off shore.

GOREE BAY is the extensive bight of the coast comprised between Cape Manuel and Cape Naze, 20½ miles to S.E. ½ E., within which line the depths are under 20 fathoms. The northern part of this bay is the most important, as here are the French stations at Goree Island, Dakar, and Rufisque; near the island is the best anchorage. The Island of Goree, with the Senegal, fell into the hands of the English in 1809, but by the Treaty of Paris they were restored to the French in 1816. The French Government has expended large sums on its military defences, and in the construction of the port of Dakar.

Goree Island lies 2¼ miles E. ½ N. from Cape Manuel; on rounding that cape a vessel bound for Dakar or the roadstead may steer direct for the island. Sailing vessels, however, seldom pass between the island and Dakar Point, on account of the strong southerly current prevailing in this channel, though it is perfectly safe, with depths of 5 to 8 fathoms in it. Goree Island is merely a volcanic rock, half a mile long, N. by E. and S. by W., by 100 to 350 yards in width, with shoal water extending 1½ cable off its western side. It is composed of black basalt and sand, of the same description as the Magdalen Islets and Cape Manuel, from which it seems to have been separated by some convulsion of nature. The southern part of it, which rises 144 ft. above the level of the sea, is the highest, like a round mountain, with the castle on its summit, and may be seen at the distance of 15 to 18 miles. The rest of the island is very low, and covered with buildings; the population amounted to 2,000 in 1892. The North point is marked by its batteries. The landing-place is on the N.E. side of the island, between the point and the back of the mountain, and to the southward is a small sandy bay. Water is procured from a deep artesian well in the castle. Boats must be provided with anchor and cable to veer in with. It is high water here, on full and change, at $8^h\ 8^m$; springs rise 5 feet.

Goree Roadstead, to the N.E. of the island, is sheltered from all winds from S.S.W. to N.N.E., round by North, and is perfectly safe during eight months of the year, from the 1st of November to the 1st of July; but during the rainy season, the squalls from the S.E. are dangerous. The best anchorage for large vessels, in either season, is at the distance of 8 cables N.E. of the landing-place, with Cape Manuel lighthouse bearing W.S.W., a sail's breadth open of the North point of the island; here the bottom is of thick clayish mud, with a depth of 10 fathoms, and it is convenient to weigh from, with the wind from any quarter.

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[*] The *Baobab* (or *Adansonia*) is a species of very large tree, with foliage of a fine green colour, but which does not keep its verdure all the year round. From the trees of this sort on Cape Verde that cape derived its name.

To fetch this anchorage from Cape Verde, in the fine season, when the winds are from N.E. to N.W., it is necessary to run close by Cape Manuel and the South point of Goree, keeping by the wind on the port tack, and sounding until in 10 or 8 fathoms. When within a mile of the land on the eastern side of the bay, tack and beat up to the anchorage.

A vessel intending to remain any time at the anchorage should moor N.E. and S.W., as the two cables will then bear an equal strain in the heaviest of the squalls. If a squall or tornado (see pages 162, 261) be suspected, and the vessel's ground tackle be unreliable, the cable should be slipped if necessary, and the vessel put to sea, passing westward of Goree Island.

At 4½ cables N.E. by N. from Cape Manuel is *Bernard Point*, low but rugged, and the land hereabout is covered with brushwood. Between Bernard Point and Dakar Point, 1¼ mile to N.E., the coast forms *Bernard Bay*, in which the depth decreases gradually from 5 fathoms towards the shore. In the S.W. angle of the bay is a yellow cliff, to the northward of which is the Dakar hospital. On the North side of the bay are seen the buildings and military barracks of the town.

DAKAR BAY is nearly 2 miles in width between Dakar Point and Belair Point to N.E. by N. ½ N., and within this line it is nearly 1 mile in depth, the water shoaling gradually from 3½ and 4 fathoms towards the shore. The town of Dakar, built along the southern shore of the bay, is the chief French naval station and settlement on the coast, the population amounting to 8,700 in 1892. Some important harbour works have been executed here, and others are under consideration, by the French Government, to make a coaling station, and to afford vessels frequenting the colony of Senegal a port of shelter from the dangerous effects of tornados, which are common on this coast in winter. Two substantial jetties have been constructed, one extending over 400 yards N.E. by N. ¾ N. from the extremity of Dakar Point; and the other is smaller, nearly 400 yards to the westward. Depths of 4½ to 2 fathoms are found between the jetties, which are convenient for coaling, but do not afford much shelter for large vessels. Under the western jetty the depths are only from 6 to 15 feet. The fort, on the extremity of Dakar Point, is in lat. 14° 40′ 15″ N., long. 17° 25′ 25″ W., the latter having been determined telegraphically from St. Vincent, Cape Verde Islands.

Large quantities of coal are stored here, and a hulk lying in the roads, in a depth of 4 fathoms, usually has over 3,000 tons on board. Other supplies are scarce, as a rule, with the exception of fish, and even fresh water cannot always be procured; there is a tank for the latter near the Santalia railway station and workshops, from which pipes are led to a boat jetty, three-quarters of a mile westward of the outer pier. There are no facilities for repairs, &c., at Dakar. Steamers call here regularly, and there is a railway to St. Louis, which it is proposed to extend from Rufisque to the Salum River. There is telegraphic communication with

St. Louis and Bathurst, and a submarine cable to St. Vincent connects it with Europe, &c. There is an export trade in gum copal, ground-nuts, &c., from the adjoining country, which is inhabited by the Jaloff nation.

The climate is unhealthy, and epidemics of yellow fever are occasionally experienced. The rainy season is from June to December, and tornados occur chiefly in July. There are hospitals both at Dakar and Goree.

Lights.—On the extremity of Dakar Point jetty, a *fixed green* light is shown, elevated 30 ft., and visible 4 or 5 miles. A small *red* light is shown on the inner pier.

When the Senegal River bar can be crossed a red and white flag is hoisted on the signal staff at Government House; a black flag signifies that the bar is then impracticable.

The anchorage off Dakar may be considered secure at all seasons, and a tornado does not raise a heavy sea here. Vessels can lie alongside the piers to discharge or receive cargo, or they can anchor in the roads in any suitable depth, as it shoalens very gradually from 6 and 5 fathoms towards the shore. Off the extremity of the eastern jetty are several sets of moorings, with buoys, in depths of 5½ to 3 fathoms.

Belair Point rises to a height of 64 ft., and is fortified. At 4 cables westward of it is a landing pier, off the cemetery, reaching into about 12 ft. water. Shoal water extends nearly half a mile S.E. of the point, and *Belair Shoal,* two-thirds of a mile E. by S. from Belair Point, has depths of 1½ to 3 fathoms over an extent of 4 cables East and West. Between these shoals there are depths of 5 to 3¾ fathoms. Bernard Point bearing S.W. by W., and open of Dakar Point, leads 4 cables S.E. of Belair Shoal; and, if wishing to enter Hann Bay, the eastern hummock of Cape Verde bearing N.W. by W. ½ W. leads 4 cables North of the shoal.

Hann Bay, on the northern side of Belair Point, is frequented for its fresh water. The watering place, more than a mile N.N.W. of the point, consisted of several pits dug in the sand on the sea-side, near a marsh, and close to a negro village. The water is neither agreeable nor wholesome, and should not be drunk until it has been filtered, acidulated, or cleansed by boiling or other means. The bay is exceedingly well stocked with fish, and hauling the seine will be attended with success. The land around is low and partly cultivated. Vessels can anchor in any convenient depth, 3½ fathoms being found at 1 mile off the watering place.

At some distance inland from Hann Bay the ground rises a little, but it is exceedingly low at the sea-side, where it presents nothing but a white sandy strand. Here may be seen the small downs, the chain of which joins the Paps of Cape Verde, and runs round the Bay of Yof. These downs rise progressively to the south-eastward, and are covered with trees as far as Cape Naze. All this coast is fronted by shoal water for about a mile off, but is much frequented by coasters, who trade with the negro villages hereabout for stock. In the night time, you may approach the coast into not less than 10 or 8 fathoms; but the land, even in the night, will direct you sufficiently to avoid the shoals.

Résolue Shoal, about 4 miles W. by N. ¾ N. from Rufisque, and about 1½ mile off shore, has only 9 ft. over it, and must be carefully avoided by vessels beating into Goree Road. *Rufisque* or *Venus Bank,* of 4 fathoms, lies 4½ miles E. by S. from the South end of Goree Island, and 2¼ miles off Rufisque, with depths of 8 to 14 fathoms around it.

Rufisque, *Rufiskwe,* or *Rufisk,* is a town containing 8,000 inhabitants in 1892, with a church, 9 miles E. ½ S. from Dakar Point. A conspicuous square white tower here is visible 8 or 9 miles, and eastward of it are several warehouses, with a jetty reaching into 7 ft. water. At 8½ cables W.N.W. of the jetty a rocky reef extends half a mile off shore, forming a small bay frequented by coasters. Larger vessels anchor in 3 to 7 fathoms, sand and mud, 3 to 9 cables S.S.W. of the jetty, and lie in safety during summer, but in the tornado season this anchorage is not good. Large quantities of ground-nuts are exported from Rufisque.

Light.—On the tower on the point, one-third of a mile westward of the jetty, is shown a *fixed red* light, elevated 52 ft., and visible 3 miles.

Between Rufisque and Red Cape, 8½ miles to S.E. by S., are several villages; the largest, named *Bargney* or *Barnier,* lies midway between, and the beach here has some dark rocks on it. *Red Cape* is the northernmost of three projections of which Cape Naze is the southernmost, and is of considerable height, with conspicuous red cliffs; on its North side is the village of *Yen* or *Hyenne.* Between Red Cape and Cape Naze, 7 miles to S. by E. ½ E., are several villages, and at 2 miles from Red Cape are some yellow cliffs.

Cape Naze, in lat. 14° 32′ N., long. 17° 7′ 20″ W., is terminated by cliffs about 1,200 ft. high, the woody summit of which may be seen, in fine weather, at a distance of 20 or 25 miles. It is safe to approach, and to the West and W.N.W. of it there is good anchorage, in 4 or 5 fathoms, fine sand; but to the South and S.W. of the cape the bottom, generally, is not good. Southward of Cape Naze the land declines in height, and the downs are partially covered with bushes. At 3 miles S. ½ E. from Cape Naze is the low wooded point named *Gombaru,* where commence the extensive banks which front the coast off the entrances of the rivers to the southward, and the bank of soundings widens very considerably. On the South side of Gombaru Point is the entrance of the little *River Soman*; the country hereabout is well wooded.

Portudal, 3 miles S.E. by S. from Gombaru Point, possesses a French factory, and may be known by a conspicuous white tower built for the garrison. It now consists of a number of huts, and is frequented by the coasters of Goree, who here embark large quantities of ground-nuts. In 1887, the inhabitants numbered 1,107. All the coast in the vicinity abounds in trees; and at 2 miles to the south-eastward of the village was a small wood, very remarkable from its trees being much higher than the rest, and which, therefore, served as a mark for the coast. The anchorage off Portudal is far from being good, and is fit for small vessels only; they lie close to the shore, athwart the little houses between the cliffs. All this coast is bordered with rocks, and must not be approached too near, as the shallow bank extends 2 miles off the village. Large vessels anchor in 6 to 8 fathoms, W.S.W. of the village, the latter depth being found at 5 miles off. *Serin Point,* 12 miles S. by E. from Portudal, has a large village on it with a conspicuous white house, and several other villages lie on the coast between.

Amboru Bank lies off the foul and rocky ground lining the coast. Its outer edge, in 5 fathoms, is nearly 7 miles W. ½ N. from Serin Point, and at less than a mile within this the reef is awash. Vessels coming from the westward must be very cautious of this shoal; the ground is very hard upon it, and close to it there is a depth of 4 fathoms. The sea breaks over the bank, and the water on it is discoloured. The passage between the bank and the shore has depths of 3 to 5 fathoms in it, and is used by coasters beating to the northward. Vessels passing outside should not approach within the depth of 7 fathoms.

Point Joal or *Gukwe*, 7 miles S. by E. ½ E. from Serin Point, is only a slight projection, and shoal water extends for 4 miles off this coast, as far as Palmarin Point. At 1 mile northward of Joal Point is a French mission station, the buildings of which are conspicuous. The village or town of *Joal*, 2 miles S.S.E. of the point, contained 1,967 inhabitants in 1887; it has a conspicuous chapel and square tower, and to the S.E. of it is the bar of *Fajodj River*, nearly dry at low water. Joal exports large quantities of ground-nuts.

Palmarin Point, 8 miles S. ¾ E. from Joal Point, has a clump of trees upon it. The shore bank narrows from hence towards *Punshavel Point*, a long narrow spit, 14½ miles to S. by W. ½ W., the shore between consisting of a wide sandy beach, backed by trees or brushwood. At 4 miles southward of Palmarin Point is the large village of *Palmarin*.

Between Punshavel Point and Cape St. Mary, 21 miles to S. ½ W., is the estuary of the Salum or Salm, Jumbas, and Gambia Rivers, a low wooded land, intersected with numberless creeks, and fronted by extensive shallow banks, which are constantly undergoing alterations owing to the silt brought down by the rivers. At the time of the survey by Captain Owen, R.N., in 1826, four small islands, known as *Bird Islands*, existed about midway between Punshavel Point and the mouth of the Gambia, but when this district was re-examined by the officers of H.M.S. *Sylvia*, in 1886, it was found that these islands had been washed away.

In sailing along the coast between Cape Verde and the Gambia, shipping must proceed with caution, as the Amboru Bank, the shoals off Joal, and the banks in the vicinity of the River Salum, are dangerous, being very shoal. At night, or in hazy weather, they should not be approached within the depth of 7 fathoms.

Salum River entrance is fronted by *Sangomar Bar*, over which there is a channel which had 8 to 12 ft. at low water, but it is subject to constant changes, and is gradually extending to the South. To mark the entrance, two *black beacon buoys* were moored on the edge of the bank, according to latest accounts (1893), one at 2¾ miles S.W. by W., and the other at 5 miles S.S.W., from Punshavel Point, the latter buoy lying in about 4½ fathoms, 2½ miles S.W. by S. from the bar. The channel into the river is marked by *buoys*, *red* to starboard, *black* to port. The best time to enter the Salum is with the beginning of the flood, when the banks on either side can be easily seen and avoided.* In 1857, Lieut. Bourdon, of the French Navy, recommended that, in taking the bar with a sailing vessel, you must be able to bear freely to the N.E. by compass, which may be readily done with the sea breeze (N.N.W.) in the afternoon. The best time is, therefore, the two or three days following the first and last quarters of the moon: it is high water then at from 4 to 6 p.m., and you can make sail for the bar at 2 or 3 o'clock the moment the breeze sets in and is well established, but not if it is too fresh, for then the breakers are strong. A pilot could be obtained at Dakar.

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* "Annalen der Hydrographie," 1889, page 414.

Within the bar the river deepens, and appears more like an inlet of the sea; depths of 4 to 5 fathoms are found along the East side of the peninsula of which Punshavel Point is the southern extremity. The bottom in the river is soft mud, and may be grounded on without danger. About 30 miles up the river, on the left bank, is a French trading station at *Fundioun*, where vessels lie alongside piers to load ground-nuts. On the opposite side of the river, 18 miles up a creek, is the town of *Silif*. On the same side as Silif, but higher up, is *Sine Creek*, up which is the town of *Fatik*, to which it has been proposed to extend the railway from Dakar. Vessels which can cross the bar can reach Fundioun without any difficulty. *Kaolakh*, a town about 35 miles above Fundioun, can be reached by vessels of 250 to 300 tons, or those drawing 8 ft., and here the tide rises about 2 feet. The river is said to be navigable for 25 miles above this.

A considerable trade is carried on here, ground-nuts being very plentiful. The river being salt, fresh water is scarce, and obtained by digging on the Punshavel peninsula; in 1886, it was reported to be *10 centimes a litre* at Fundioun ![*]

Red Bank.—*Jumbas River* is the wide creek 6 miles S.E. of Punshavel Point, fronted by the extensive shoals named *Red Bank* and *Bird Island Bank*, the latter reaching 6 miles off shore, with 4 fathoms close to their edge. Several patches on these banks dry at low water, but there are passages between them into the river. *Bird Spit*, the western extremity of these banks, is very dangerous, the soundings here suddenly decreasing from 4 fathoms to 4 feet, exactly midway between Punshavel Point and Cape St. Mary; it is marked by a *buoy* to the westward, described hereafter. These banks, being steep-to, are especially dangerous to approach during the Harmattan season, because the haze then makes the shore appear farther off than it really is.

Banjala Creek, 10 miles N.E. ½ E. from Cape St. Mary, is very shallow, but it is said that boats or small steamers can enter it when the sea is smooth, and pass through the creeks to Salum River. *Jinnak Creek*, or *Fourth River*, 2¼ miles S.E. of the Banjala, leads into the latter, passing close northward of *Buniada Point;* this creek forms the boundary between the French colony of Senegambia and the English colony of the Gambia, the line passing to the eastward along the parallel of 13° 36′ N.[†]

GAMBIA, the northernmost English colony on the West African coast, has an area of about 7,000 square miles, but the population was only

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[*] "Note sur le Saloum," par M. C. de Nordeck, in the "Annales Hydrographiques," 1885, pages 236—239.

[†] From Buniada or Boonyadoo to Jukarda Creek, 42 miles up the river, is a line of coast known as the *Ceded Mile*, being 1 nautic mile in breadth, the sovereignty of which was ceded to England, by treaty with the king of Barra, 1826.

14,266, at the census in 1891; the town of Bathurst contained about 6,000 people. A considerable trade is carried on, the principal exports being ground-nuts, india-rubber, gums, palm kernels and oil, hides, wax, ginger, and pepper, their total value in 1892 being placed at £172,197. The mails from London reach Bathurst in about twelve days.

The advantages of this noble river for carrying on trade with the natives in the interior were well known nearly three centuries ago, for a company was formed in England for that purpose in 1618. From the time of the first voyager, Thompson, at that period, up to that of Mungo Park, in 1795, it was considered that the Gambia and Senegal were branches of the Niger. Several expeditions were sent out, and in 1664 the English factory was founded on the small Island of St. James, about 17 miles above St. Mary's Island.

In 1816 a new settlement, the present Bathurst, was formed at the Island of St. Mary, which was purchased from the King of Combo; and on the opposite bank a large tract of country was purchased from the King of Barra, thus giving command of the mouth of the river.

The GAMBIA RIVER was first surveyed in 1826, by Captain Richard Owen, R.N., and his assistants Messrs. Tudor and Mercer, in H.M.S. *Leven;* they also took soundings all the way up to Pisanea, about 165 miles from the entrance. In 1871, the course of the river, from Pisanea to the Falls of Barakonda, was examined by the boats of H.M.S. *Growler*, and, since then, further information has been obtained by the officers of the *Sylvia* in 1886, the *Acorn* in 1887, and other of H.M. ships.

Between Cape St. Mary and Bird Spit, the entrance of the river is 10½ miles wide, but at 6½ miles eastward of the cape it suddenly contracts to a breadth of 2¼ miles between Bathurst and Barra Point. *Horseshoe Bank*, reaching 2 or 3 miles to the S.W. of Bird Spit, is reported to have only 12 ft. water upon some parts of it, and the navigable channel passes southward of it.

Cape St. Mary makes like a low plain from a distance, with an acclivity towards the interior. It is about 60 ft. high, with red cliffs, and on it are some cocoa-nut palms, a small fort, and a white house used by convalescents. There was also an octagonal lighthouse on it, but the light has now been discontinued for many years. The ground off the cape is foul, but there are depths of 4 to 5 fathoms at 1 mile off it.

Between Cape St. Mary and Bathurst, 6 miles to S.E. ½ E., the coast is fronted by extensive shoals, *Banyan* or *St. Mary Shoal*, a dangerous rocky shelf nearly dry at low water near its centre, extending 6 miles N. by W. from Bathurst. Near its extremity the depth is about 2 fathoms, and within a space of 1½ mile farther on are two detached patches of 2½ and 2¾ fathoms, the latter lying 5 miles N.E. ¼ E. from Cape St. Mary, with 6 fathoms close to its northern side. To the eastward of these shoals is the *Middle Ground*, consisting of two detached patches of 2½ fathoms, with a narrow channel between; northward of these is *African Knoll*, of 2¾ fathoms, at 6 miles N.E. by E. ½ E. from Cape St. Mary, and here is the narrowest part of the main navigable channel, less than a mile in width, with a depth of 8 fathoms.

Buoys.—The entrance of the Gambia is marked by four *conical* buoys, but they are liable to drift, and cannot be depended on. According to the most recent information, their stations are as follows :—

No. 1, *Northern* or *Red Bank buoy* is painted *red*, surmounted by a *cage*, and lies in 5½ fathoms, 4 miles W.N.W. of Bird Spit, with Cape St. Mary bearing S. by E. ⅜ E., distant 12¾ miles.

No. 2, *Fairway buoy*, *black* and *white chequered*, lies in 4¾ fathoms, 5⅜ miles S. by W. ⅜ W. from Red Bank buoy, with the centre of the red cliff of Cape St. Mary bearing S.E. ⅛ S., distant 9 miles.

No. 3, *Middle buoy*, painted *red*, and surmounted by a *cage*, lies in 4¼ fathoms, 5 miles E. by S. ¾ S. from the Fairway buoy, with Cape St. Mary bearing S. by E., distant 5½ miles.

No. 4, *African Knoll buoy*, painted *black*, and surmounted by a *cage*, lies 6¾ miles E. by S. ½ S. from Middle buoy, and nearly half a mile E.N.E. of the N.E. side of African Knoll, in 8 fathoms, with Cape St. Mary bearing S.W. by W. ⅛ W., distant 6½ miles, and the flagstaff at the North part of Bathurst S. ¾ W., 6¾ miles. It thus lies nearly in mid-channel.

Directions.—Vessels bound to the Gambia should endeavour to make the land on the parallel of 13° 33′ or 13° 30′ N., that of Cape St. Mary, the the land here being higher and more distinct than the other parts of the coast hereabout. On the northern side of the river entrance, on the contrary, the coast is covered by bush, and, as a rule, nothing can be distinguished in the mirage but the larger trees. In approaching on the parallel of 13° 33′, the depth of 100 fathoms, fine dark sand, will be found at 50 miles westward of Cape St. Mary; 20 fathoms at 30 miles, and 10 fathoms at 18 miles, at which latter distance the tops of the trees will be just discernible in clear weather. When the depth decreases to 6 fathoms, the vessel will be 12 miles N.W. by W. from Cape St. Mary; between this and African Knoll the depths are from 4 to 6 fathoms.

When advancing from the northward, after rounding Cape Verde, or when leaving Goree, bring Cape Manuel lighthouse astern bearing about N. by W., and continue on this course, S. by E., keeping the lead constantly going, and when nearing the estuary approach the coast no nearer than in 7 or 6 fathoms at the least till Cape St. Mary comes in sight. When near the entrance of the Gambia, the ground will generally be found an oozy sand or mud; but, near the cape, sometimes sand and sometimes red shells will be found.

From the southward, the rocky shoals off Bald Cape are the chief dangers in the approach, but the land here is high, and they will be safely passed by not shoaling the water under 8 fathoms. A course can then be steered for the Fairway or Middle buoys.

If the buoys are in position, and can be made out, a steamer will find no difficulty in entering or leaving the Gambia without a pilot; those drawing 24 ft. should take a pilot, as the shoals are liable to vary in their positions and depth. As a rule, sailing vessels not drawing over 10 ft. will find no difficulty in beating in or out, with a favourable tide. On no account should an attempt be made to enter without a pilot until African Knoll buoy is made out. It may be advisable for a stranger not to proceed in without a pilot, unless his vessel draws less than 12 feet.

If the buoys cannot be made out, a vessel should anchor in 5 fathoms, off Cape St. Mary, and, if necessary, send to Bathurst for a pilot. A pilot cutter is usually at anchor near the Fairway buoy, and pilots may also be obtained at Goree. During the rainy season landing can be effected on the sandy beach southward of Cape St. Mary; at other seasons the breeze sets in fresh from the sea, creating a surf which renders landing unsafe. Fish is abundant on the North side of the entrance.

Vessels sighting the Northern buoy, should immediately steer southward to sight the Fairway buoy, from which the house on Cape St. Mary may be seen in clear weather. From the Fairway buoy, an E. by S. ½ S. course made good passes just northward of the Middle buoy, and leads up to African Knoll buoy, and the least depth found will be 4½ fathoms. Nearer Horseshoe Bank the depth is 5½ fathoms, but vessels should go no nearer to it than to the distance of 1½ mile northward of the Middle buoy; in hazy weather, with an ebb tide, great care will be necessary to prevent being set too far towards Horseshoe Bank. After rounding African Knoll on its northern side, alter course to S. ¾ W., keeping in mid-channel. Having approached within 1 mile of Barra Point, from which a small spit stretches off to about a quarter of a mile, keep over for mid-channel between that point and Banyan or Bathurst Point, with depths of 8, 9, 10, and 12 fathoms between the two points, muddy ground. When abreast the town of Bathurst, anchorage can be taken up as convenient.

The best anchorage, out of the influence of the whirl of the tidal stream, is in 10 fathoms, mud, with the South end of the town bearing W. by N. ½ N.; the eastern end of the town bearing N. ¾ E.; and Barra Point clump, N.E., northerly. Another berth is in 7 fathoms, about 2 cables off the town, with Fort Bullen (on Barra Point) bearing N.E. by E., and the East extreme of Bathurst S.S.W. A vessel should either moor, or lie with a long scope of cable, as the constant swinging makes a foul anchor almost a certainty, if riding with little chain out.

In leaving the river, the best time to weigh from Bathurst under sail is on the last of the flood, so as to gain mid-channel before the full strength of the ebb, which, as it sets directly down upon the Middle Ground, would, in light winds, make it necessary to anchor in order to avoid it. After weighing, stand over towards Barra Point, keeping the lead going, and make very short tacks off the bank on the eastern side of the channel, especially when nearing African Knoll, where the set of the ebb tide is always the strongest. The sea breeze from the north-westward is always a beating wind, and even the land breeze in the morning is seldom sufficiently to the eastward to lead out without making a tack.

Tides.—It is high water at Bathurst, on full and change, at $9^h\ 10^m$; springs rise 6½ ft., neaps 5 feet. Spring tides run very rapidly, the ebb stream sometimes running 8 hours, setting strongly towards St. Mary Shoal and the Middle Ground, and great caution is necessary in calm weather. The flood is not so strong, setting over the shoals, but sweeps rapidly past the town.

St. Mary Island, the eastern angle of British Combo, is low and marshy, and is separated from the mainland by a very narrow creek, called *Oyster Creek*; it is about 4 miles in extent, East and West, by less than 2 miles in width, with the town of Bathurst on its eastern point. At 2½ miles N.E. by E. from Bathurst is *Barra Point*, on which stands *Fort Bullen*, near a conspicuous clump of trees.

BATHURST is a small prosperous-looking town, with several excellent stone houses, especially on the wharf where those of the merchants are situated. At the census in April, 1891, the population of the colony was estimated to number 14,266, of whom only 48 were Europeans, and perhaps one-third reside in Bathurst. Supplies of fish and inferior beef and poultry may be obtained here, but the bread is good; vegetables and fruit are usually very scarce. The only fresh water to be had is from private wells; but, by close work in the dry season, as much as five tons a day may be obtained. Better water may be obtained from Jillifree, but vessels are advised to rely upon their condensers, rather than use water from the shore. Wood may be had at the beach, well dried, in convenient lengths for stowage. A small quantity of coal is usually stored here. There is telegraphic communication with Europe via St. Iago, Cape Verde Islands; also with Goree, St. Louis, Bissao, Conakry, Isles de Los, and Sierra Leone. There is a sailors' hospital here.

The Climate of the Gambia is naturally insalubrious, and all Europeans who can do so leave it during the bad season, when fevers, rheumatism, and dysentery are prevalent. The worst months are September, October, and November; from December to March it is considered to be fairly healthy. Vessels stationed here are recommended to make periodical trips to sea for a day or two, to preserve the health of the crews. Severe tornados are sometimes experienced in July. (See also pages 166—168).

Above Bathurst the river is navigable for vessels drawing 10 ft. as far as the trading station of *Yarbutenda* or *Yahlahlenda*, a distance of about 225 miles, and about 25 miles farther on, with depths under 10 ft. in the channel between, are the falls of *Barraconda*, which stop the navigation; from this to Fort St. Joseph, or Gallam, the French settlement on the Senegal, the distance is about 150 miles, or five days journey on foot.

Between Bathurst and MacCarthy Island the channel is liable to changes in depth. In April, 1877, H.M.S. *Seagull*, drawing 11 ft., reached MacCarthy Island, and found a least depth of 14 ft. at 5 miles below it. In May, 1887, H.M.S. *Acorn* found a least depth of 3 fathoms as far as *Deer Island*, 120 miles above Bathurst.

Above Bathurst the river expands into a basin about 6½ miles in diameter, but the navigable channel is only 1½ mile in width between the shallow banks on either side. Between Barra Point and Dog Island Point, 7½ miles to South, and on the same side of the river, the coast forms a shoal bay, and the flats extend from it into the middle of the river. *Dog Island Point*, and the islet close off it, are low and wooded, and a cluster of trees rises about a quarter of a mile inside the point; shoal ground of rock and mud extends nearly 1½ mile S.W. by S. ¾ S. from the point, with 7 ft. on its edge at low water, and may be extending. Here the land turns abruptly to S.E. ½ E., the river narrowing to 4½ miles in width, and at 6½ miles distant is *Lemaine* or *Lemon Point*, at half a mile westward of which is a large clearing in the bush.

Albreda, or *Albradar*, 1½ mile eastward of Lemaine Point, was originally a French settlement, and here are several white houses. At half a mile farther on is the old English settlement named *Jillifree*, where fresh water may be obtained. Vessels anchor here in depths of 3 to 4½ fathoms. About 1½ mile S.E. ¾ S. from Albreda are the ruins of *Fort James*, with some trees around it, standing on an islet near the middle of the channel, 16 miles above Bathurst.

To go up to Fort James, steer in mid-channel, with the town of Bathurst astern bearing North, which leads to a fair offing S.W. of Dog Island Point. The course hence, in the fairway, to abreast Lemaine Point, is S.E. ¾ E., 6½ miles; and thence to Fort James, E. by S. ½ S., 4 miles.

In order to avoid the shelf which extends from the Banyan or western shore, approach no nearer to that shore, in turning, than in 5 fathoms; nor nearer the Barra side, when below Dog Island Point, than in 4 fathoms; but if near that point, then in 6 fathoms. Then keeping in mid-channel, to avoid the shoals on each side, you may haul in and anchor before Albreda in 3 to 4 fathoms, half a mile S.S.W. from it.

From Fort James the river turns to East and then E.N.E., and at 14½ miles distant is *Moota Point*, on the South shore, opposite *Jukarda* and *Suara Creeks*, the river here narrowing to 1¼ mile; the depths of this reach, in mid-channel, are 5½, 4½, 4¼, to 6, 6, and 7 fathoms. Pursuing thence an easterly course, its depths alternately shoalen and increase to a great distance, and there are numerous villages and clearings on both banks. The river banks are muddy and covered with mangrove, rendering landing difficult except at the villages.

Vintang Creek, on the South bank, about midway between Jillifree and Moota Point, runs about 120 miles inland, and is navigable to *Sandeng*, a distance of 40 miles, for vessels drawing 13 ft., but they would find some difficulty in turning there if exceeding 150 ft. in length. The deepest channel, as a rule, is in the centre, and varies at low water from 10 ft. in the broad places to 10 fathoms in the narrow. In January, 1892, H.M.S. *Sparrow*, drawing 13½ ft., proceeded 7 miles above *Kansala*, which is 15 miles from the entrance; the least depth obtained at low water was 16 ft., and the vessel anchored off *Sangajor* wharf, having just room to swing. There is very little trade, and supplies are very scarce, but a few fowls and eggs can be obtained occasionally. It is high water at Kansala, on full and change, at $0^h 5^m$; springs rise 6 ft., neaps 3 feet. The greatest rate of the stream observed was 2½ knots an hour.

Tides.—At Albreda it is high water at $1^h 20^m$; at Moota Point about $2^h 30^m$; and at Tendeba, about 21 miles above the latter, at 3^h later than at Bathurst. In the rainy season the flood is not felt higher than at *Kaua*, 100 miles from the entrance, and above *Tankrowall* (5½ miles above Moota Point) the water is fresh.

MacCarthy Island, about 150 miles above Bathurst, has an area of 69 square miles, and contains a considerable population. It is about 5½ miles long, by 1 mile wide, and the river is navigable up to it for vessels of large tonnage, as stated on pages 655 and 658; the river is here about 200 yards wide, and in April, 1887, the tidal streams were regular, the flood running 4 hours, and the ebb 8 hours, the rise being 6 feet. A steamer makes occasional trips between Bathurst and the island.

Seasons, &c.—Between the Gambia and the Isles de Los, the rainy season sets in between April 1st and June 1st, lasting to the end of November or even December, the rain being almost continuous during July and August. The fine season sets in with the Harmattan (page 164), which blows between S.E. and N.E. In this season, when near the coast, light East and N.N.E. winds are experienced during the morning, the sea-breeze usually setting in after mid-day. Tornados occur in April, May, September, and October.

The Coast of Kombo, from Cape St. Mary, trends 10 miles W.S.W. to *Bald Cape*, with several villages along it, and is fronted by sunken rocks extending in some places 2 miles from the shore. At 2½ miles S.W. of Bald Cape is another projecting point, with a rivulet of fresh water on its South side. These two points are fronted by *Tongui Reefs*, which extend 3½ miles off shore, and on them, at 1½ mile W.N.W. of Bald Cape, lie the two small *Bijol Islets*, covered with grass; the reef extends 2½ miles W.N.W. of the islets, and the swell always breaks on it. Some of the off-lying rocks uncover at half-ebb, and there are depths of 2 and 3 fathoms at a quarter of a mile from their western extreme, which bears W. ¾ S., distant 14 miles, from Cape St. Mary, and 4 miles N.W. by W. ½ W. from Bald Cape.

In the vicinity of Cape St. Mary the bottom varies in colour all along, but it becomes whiter to the southward. When past the cape you find a reddish sand, which, at 8 or 10 miles farther South, changes into a gray, then into a whitish, sandy bottom; and, about Cape Roxo, it becomes such fine sand as that which is put into the time glasses. The varieties of ground extend from 25 fathoms in the offing to 5 fathoms off the shore.

St. Pedro or *Allahi River*, 19 miles S. ¾ W. from Bald Cape, forms the southern boundary of the Gambia colony, thence to the southward, as far as Cape Roxo, being claimed by France. At 29 miles S.S.W. of the St. Pedro is the entrance of the River Casamanze, and to the northward of the latter several shallow branches of this river fall into the sea. All this coast is very low, with a sandy beach, and covered with trees; the central part, in the vicinity of the St. Pedro, is one low and continued forest, with clusters of high trees, at a distance resembling islands.

At the River St. Pedro commences the extensive shallow bank which fronts the coast as far as and beyond Sierra Leone. At 19 miles north-westward of the entrance of the Casamanze, is a narrow bank of 4 fathoms, 5 or 6 miles long N.E. and S.W., with depths of 5 to 6 fathoms close around it. In 4 fathoms, about 7 miles off the entrance of the Casamanze, the bottom is mostly red sand, and at 11 miles W. by S. from the entrance is a bank of 4½ fathoms.

The **RIVER CASAMANZE, or Kasamanza,** was surveyed by Captain Boteler, R.N., in 1829, but no dependence can be placed upon the chart, as the banks in the entrance are subject to constant change. The Portuguese had several establishments on the banks of this fertile river, now ceded to France, and they ascended to the distance of many miles from its mouth, carrying on an advantageous trade, especially in ivory, hides, aromatic seeds, and dye-wood, with the Feloop and other negroes, who inhabit the banks of the river.

During the dry season, October to May, winds between N.N.W. and E.N.E. prevail, and they are variable from the westward during the rest of the year. Thick fogs are common throughout the year.

The land being low, the entrance is not easily recognised from seaward; it is 1 mile wide, and lies between *Jogué Island* on the North, and *Guimbering Island* on the South. On the South end of Jogué, where pilots are stationed, is a white triangular *beacon*, and on the northernmost elevation of Guimbering is a conspicuous white patch. Vessels waiting for a pilot should anchor in 4 fathoms, with the patch bearing S.E. by S. ¾ S.

The channels over the bar are liable to great variations in depth and direction. In 1885, there was a least depth of 3¾ fathoms at low water in the main channel, which ran about W. ½ S. from the entrance, but early in 1890 the depth was stated to be only 10 feet. Vessels can ascertain latest particulars from the French pilot at Goree. Inside the depth increases to 7 and 8 fathoms, but the channel becomes barred again above Carabane.

Carabane, on the South bank, 3½ miles within the entrance, is the chief French settlement on the river, and there is anchorage 3 cables off it in 8 fathoms, mud. A small *fixed red light* is shown on the quay at night. Oil is the chief export.

About 21 miles above Carabane is another French settlement at *Berrin* or *Brin*, at 9 miles beyond which is *Zinghicor* or *Zighinkor*, which was the principal Portuguese establishment. The soundings in mid-channel, from the entrance to the latter place, varied from 8 to 4, 6, 2¾, 5, 6, 3½, 8, and 5 fathoms, and large schooners proceed far beyond this. Vessels drawing 6 ft. can ascend as far as *Sejeu* or *Sedhiou*, a flourishing French settlement, 90 miles from the entrance, where the thermometer is stated never to fall below 82° F.

Cape Skyring, about 10 miles S.S.W. of the Casamanze entrance, consists of low red cliffs. A small patch of 2¼ fathoms lies 5 miles W. by N. ¾ N. from the cape, with 6 and 7 fathoms close around. Vessels can anchor off the cliffs, but in a depth of 2 fathoms the bottom was so sticky, that the lead was brought up with difficulty.

CAPE ROXO, 5 miles S. by E. ½ E. from Cape Skyring, is improperly called a *cape*, being an obtuse point of low land, with shoal water extending nearly 2 miles off it. When bearing East or E.S.E., it presents a down of white sand, of moderate height, covered with brambles. On one of the points formed by the coast to the northward, are a number of tufts or patches, of a remarkably *red* colour, and it is supposed that, from these patches, the name of *Roxo* (Red) has been imparted to the headland, although they are about 2 miles distant from it. This cape is the northern boundary of Portuguese Guinea.* M. Roussin says, that in approaching Cape Roxo, the soundings are regular, but the depth inconsiderable. From the River Cazamanze, to the distance of 2 or 3 miles from shore, the depth is only 6 to 4 fathoms, and at 10 miles to seaward 8 and 7 fathoms is met with.

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* In the "Boletim da Sociedade de Geographia de Lisboa," 1887, pages 465—522, is an interesting article on "Guiné Portugueza," by Captain F. A. M. Geraldes, showing the present condition of the colony.

Cape Barella, 8 miles S.E. ¼ E. from Cape Roxo, is distinguished by its white sand-hills and reddish clay cliffs, above which rise some high trees. At 8 miles farther on is *Jufung Point*, low and wooded, whence the coast turns to the eastward to the entrance of the River Cacheo. All this coast is fronted by a broad shallow flat.

CACHEO RIVER, or Rio San Domingo, is fronted by an extensive and dangerous range of shallow shifting banks and shoals, on many of which the sea is always breaking. The dangers lie eastward of the line of S. by W. from Cape Skyring, the outer shoals being *Coimbra Bank*, 5 miles S. ¾ W. from Cape Roxo; *Falulo Breakers*, 5 miles farther on in the same direction; and *Parcels Breakers*, 6 miles still farther on. The western extreme of the latter is in about lat. 12° 4′ N., long. 16° 44′ 15″ W., and hence the edge of the bank trends away to the S.E. towards Cayo Point. Two channels lead between these dangers to the river entrance, the *Northern* or *Direct Channel* having 12 ft. least water, and the *South-West Channel* with 15 ft. at low water, but they should only be attempted under favourable circumstances.

As in other West African rivers, the bottom in the channels is always soft mud, the banks being hard sand; the lead, therefore, must be carefully attended to. The land being so distant there are no marks available, and the lead, latitude, and look-out are the only reliable guides.

Direct Channel.—Having carefully sighted Cape Roxo, not approaching it within 2 or 3 miles, when it bears E. by N., distant not less than 3 miles, alter course to S. by W. for 11 miles, making this course good, in depths of 6 to 7 fathoms, and passing westward of Falulo Breakers, which are always visible except when the sea is very smooth. The vessel will then be in lat. 12° 8′ N., in the fairway of the entrance, and should anchor in 6 or 7 fathoms, to make sure of the latitude by observation. With the sea breeze and flood tide, with boats ahead if possible, and an anchor ready to let go, steer E. ¾ S., southerly, leaving Jufung Breakers to port, when the depth will decrease to 2 fathoms, and then again suddenly deepen. Bring the high trees of Bolola to bear E. ½ S., and continue on this line to within 2 miles of the beach. Then alter course more to the eastward, keeping in the narrow channel between the shore and the northern edge of Domingo Bank, till Bolola Point bears N.E., distant about 1 mile. Here anchor may be dropped, or a vessel drawing 12 ft. may steer over the bank, S.E. by E. ½ E., for Cape Mata, into the main channel of the river. Larger vessels must send boats to find out the deepest water.

South-West Channel is preferable to the other. In approaching its entrance, when Cape Roxo bears E. by S. ¾ S., distant about 4 miles, alter course to S. by W. ¾ W., and this made good for 20 miles will place a vessel in 7 or 8 fathoms, in lat. 12° N. Here anchor to verify the latitude, and to make preparations as before. On weighing, steer along this parallel, E. by S. ¾ S., for 15 miles, passing southward of Parcels and Cachops Breakers, and the depth will decrease to 5 fathoms, with the Cayo Islands visible in clear weather, bearing about S.E. by S. Then alter course to N.E. ¾ E., and continue for about 9 miles on this course, when Bolola Point will be seen ahead, about 5 miles distant, and the vessel will be on the edge of the bar. According to the chart, the least depth found will be about 3 fathoms, but on the bar the depth is 2¼ fathoms at low water.

When across the bar the depth suddenly increases to 4 and 6 fathoms, and the course should be altered to East, which continued for 7 miles will lead in mid-channel to abreast Cape Mata, where there is anchorage in 6 or 7 fathoms, good holding ground. Above this, a vessel will proceed safely by keeping in mid-channel.

Tides.—It is high water on the bar, on full and change, at $7^h\ 45^m$, and springs rise 8 feet. The flood sets S.E., and the ebb N.W., the latter generally running 8 hours, but it is never very strong, except towards the end of the rainy season.

Cacheo River Entrance, between Bolola Point and Cape Mata, is 5 miles in width, but within the cape it gradually narrows to 3 and 2 miles, and under, and the banks are covered with mangroves. *Bolola Point* is low, with some lofty trees 2 miles westward of it, and to the N.W. of it is the large village of *Bolola*, on the West side of *Katon Bay*. From hence there is said to be communication, by a creek, with Zighinkor on the Casamanze River.

Cacheo, on the South bank of the river, 11 miles above Cape Mata, is a Portuguese establishment, and was formerly very considerable, the country around being singularly fertile and well peopled. Vessels anchor off the fort, in 5 fathoms.

Batoor, 70 miles up the river, is a large town inhabited by the Mahommedan Mandingo tribe. Here the flood tides ceases to be felt, and the mangroves begin to disappear. About 15 miles above Batoor is the village of *Farin*, where the rise and fall of the tide is said to amount to 9 ft., and vessels drawing 12 ft. can reach within 4 miles of it. A short distance above this the river channel is barred by rapids.

JEBA RIVER appears more like a wide inlet of the sea, faced by the Bijouga Islands and shoals, with many dangerous detached banks. It is approached by two deep channels, Jeba or Great Channel, passing northward of the islands, and Orango Channel, the approach to the Rio Grande or Bolola, southward of them. There appears to be but little inducement to visit this uncivilised region, beyond the small Portuguese settlements of Bissao and Bulama. Above Bissao, the navigable channel is rendered tortuous by shoals. The waters of this river begin to rise in July, and fall during September and October.

BISSAGOS or BIJOUGA ISLANDS.—This archipelago is an extensive assemblage of islands and shoals between the parallels of 10° 40′ and 11° 40′ N., and between the meridians of 15° 30′ and 17° W. Of the interior navigation among the isles little is known, and the hostile disposition of many of the inhabitants renders it probable that no complete survey of it can be made without danger.* The principal islands and islets are fifty-three in number, besides many rocks, all surrounded by shoals and reefs, as shown on the chart. The islands are of volcanic origin, and very fertile, but inhabited by untrustworthy savages, and the climate is stated to be very unhealthy. The waters which surround the Bissagos are far from being supplied with fish, and it is erroneously affirmed, in some works on Africa, that amongst these islands cargoes of salt fish may be procured. Mud prevails too much in the bottom; and the few fish which are found are not even considered wholesome. No dependence can be placed on this resource, between the Gambia and the Isles de Los.

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* Some few particulars are taken from a Paper on these islands, by Mr. E. Stallibrass, appearing in the "Proceedings of the Royal Geographical Society," October, 1889, pages 595—601. Later and completer accounts are taken from an article in "As Colonias Portuguezas," of February 21st, 1891, entitled "O Archipelago dos Bijagos."

The channels were partially surveyed by the officers under Captain Roussin, in 1818, and Captain W. F. Owen, in 1826—1834; and to their surveys we owe most of our knowledge of the navigation.

Bijouga Bank.—*Bijouga Breaker*, at the N.W. extremity of the extensive shallow bank fronting the western face of the islands, has depths of 12 to 18 ft. over hard sand, with 4 to 10 fathoms close around it. Its western extremity is in about lat. 11° 30′ 30″ N., long. 16° 57′ 15″ W., 50 miles S.W. by S. ¼ S. from Cape Roxo, and 28 miles W. by N. ¾ N. from Karashe Island, the nearest land. From hence the bank extends to the southward and south-eastward, for 75 miles, towards Orango Channel; and the flat, which is from 13 to 25 miles in breadth, is interspersed with breakers, banks above and under water, and islands, either dry, or drowned and marshy, the detail of which is little better than unknown. The tide of ebb runs very strongly to the S.W. over the flats; within the heavy breakers the ebb runs W. by S., and the flood E. by N. The tide, on full and change, rises 11 feet.

Bayadère or *South Breaker*, the southernmost known danger on Bijouga Bank, has depths of 2 to 3 fathoms over it, and 6 to 14 fathoms close around, its southern extremity being in about lat. 10° 40′ N., long. 16° 8′ 30″ W., 21 miles southward of Orango Island, the nearest land.

Jeba Channel is obstructed at its entrance by Warang, Cayo, Middle, and Karashe Banks, all steep-to and dividing it into four deep channels, of which the northern or Cayo Channel, having depths of 6 to 8 fathoms, is that recommended for large vessels. The main land, forming the North side of this channel, is intersected by several rivers, which divide it into islands, named Jatt, Bassi, and Bissao. The islands, generally, which border Jeba Channel, are not high. The beach is generally of white sand, interspersed with black and red rocks, which, being covered with lava, are doubtless, with the whole archipelago, of a volcanic origin. They are all well wooded to the sea-side; and the height of the trees, with their vigorous appearance, indicate that the soil must be fertile. Bissao is not so thickly wooded as the others; but this is owing to the clearance the Portuguese were obliged to make for their safety, as this island is equally fertile with the rest. The large islands of the archipelago are inhabited by a race of negros, known by the name of *Papels*.

Warang Bank, lying off the northern side of Bijouga Bank, is 7 miles in extent East and West, and partly dries at low water, with depths of 5 to 9 fathoms close around it. Its eastern extremity lies 19 miles W. by S. ¾ S. from Cayo Point.

Cayo Bank, about 2 miles in extent N.W. by W. and S.E. by E., and very narrow, has depths of 2 to 3 fathoms over it; the 5-fathoms line extends 2½ miles off its N.W. end, its extremity lying 5 miles S.W. ½ S. from Cayo Point. *Middle Bank* lies parallel with Cayo Bank, at about 1½ mile to the S.W. of it, and has only 3 ft. water over its central part.

Karasche Bank, 2 miles southward of Middle Bank, with depths of 10 to 15 fathoms between, is a narrow bank 8 miles in extent W.N.W. and E.S.E., with heavy breakers over it, its central part drying at low water. From the western extremity, in 3 fathoms, Cayo Point bears N.E. by N. ½ N., distant 10 miles. At 5½ miles to the southward of Karasche Bank is the North side of the bank fronting the island of the same name, which forms part of the South side of Jeba Channel. The channel between Karasche Bank and the island has irregular depths of 7 to 14 fathoms, and the bottom is bad.

Jatt Island forms the northern side of the entrance to Jeba Channel, and its western side is fronted by an extensive shallow flat, on the northern part of which there are heavy breakers at 7 to 9 miles off shore. This flat extends 5 miles W. by N. ½ N. from *Cayo Point*, the western extremity of the island.

Cayo Island, 38 miles S. by E. ½ E. from Cape Roxo, lies on the bank, southward of Cayo Point, and though small is conspicuous, and very useful as a sailing mark. When on an easterly bearing, it appears like three islets, but on nearing will be found to be connected with a flat, which is common to all, though intersected, at high water, by shallow lakes. Its soil is sandy, and mixed with flinty rock. The beautiful trees with which it is covered may be seen, in clear weather, at 10 to 15 miles off.

Bassi Island is separated from Jatt by *Catherina Bay*, a wide but shallow creek. *Arlett Point*, the southern point of Bassi, is very low, with a village on it; at 2½ miles West of it is *Arlett Bank*, of 2½ to 3 fathoms, which thence extends 3 miles to N.W. by W. *Ancora Islets* lie nearly 3 miles E. by S. ½ S. from Arlett Point, and the southern one had a conspicuous tree on it. These three low islets lie on the bank which obstructs the entrance to *Balantes Bay*, the deep inlet which separates Bassi from Bissao Island.

Bissao Island, forming the western side of the entrance to Jeba River, is extremely fertile and thickly populated. *Biombo Point*, its S.W. extreme, is low, and at 4 miles S.E. ½ E. from it is the dangerous *Martinho Bank*, a narrow ridge with 6 ft. water near its centre, and 2½ miles in extent East and West. Vessels should not attempt to use the narrow channel northward of this bank. *Martinho Point* is a bend in the coast, 9 miles E. by S. of Biombo Point, and at 6 miles E.N.E. of it is a conspicuous clump of trees named *St. Martin Grove*, 1 mile inland. There was also a conspicuous tree 1¾ mile westward of the grove. At 3 miles S.E. of the grove is *Bernafel Point*, off which a shallow spit extends 1½ mile.

At 3½ miles East of Bernafel Point is a conspicuous islet named

Passaro or *Bonn*, 1 mile off shore, and at 2½ miles above this another and larger islet named *Rey*, lying off the town of Bissao.

The South side of Jeba Channel, as before stated, is formed by the northern islands of the Bijouga group. On proceeding upward, when off Bassi, will be noticed the large bay formed between *Karasche*, *Corbelha*, *Mayo*, and *Formosa Islands*, occupied by shoals. On the banks eastward of the latter will be seen the *Papagaio* or *Parroquet Islets*, opposite Martinho Bank, and from hence to E.N.E. the southern side of the channel is formed by *Arriscado* and *Gancho Banks*, parts of which dry at low water.

Tides.—The usual prevailing currents on the coast to the northward of Cape Roxo are found to be completely changed on passing this cape. They have here no longer one direction only; and, in all the channels of the Bissagos, are suspended by tides, which are more or less regular. Those in Jeba Channel are perfectly so. Westward of Cayo Island the flood sets S.E. and the ebb N.W., each six hours, or nearly so, with the exception that the current gradually assumes these directions, requiring nearly an hour, from the change, before it is completely settled in its course. The flood generally sets to the northward, and the ebb to the southward. The greatest difference which has been observed between the high and low-water marks, is 8 ft.; and at the equinoctial full moon the rate of the flood and ebb is about 1½ mile an hour; at other times it never exceeds 1 mile.

At the entrance of Jeba Channel, at 20 miles to the westward of Cayo Island, it is high water, on full and change, at 9ʰ 15ᵐ. From the meridian of Cayo, and as far as that of Passaro Islet, the stream follows the direction of the channel; and here the tides are regular. It is not known that the length of the ebb exceeds that of the flood; the greatest rate of either never exceeds 2½ miles per hour, in spring tides, and the rise is found to be 8 ft., as outside the channel.

At Bissao anchorage it is high water, on full and change, at 11ʰ. Here the rate of the highest tides rarely exceeds 2·6 miles per hour, and the rise is never more than 14 feet. In common tides the rate is not more than 2 miles per hour, and the rise is 7½ feet.

Current.—Vessels approaching the coast hereabout must beware of the current. In March, 1856, Captain Canal, of the French ship *Agly*, proceeding to Bissao, encountered a most powerful southerly current. He had allowed for 1½ knot, but having become entangled to the South of Karasche he found that he had been set at the rate of 3 *miles per hour.*—(See pages 323—324.) He grounded on a shoal, but after five days he contrived to pass safely among the islands, and arrived at Bissao. He sent a boat out to sound, and by that and the colour of the water he managed to arrive without casualty.

Winds.—In Jeba River approach the winds follow nearly the direction of the land, and vary their course according to that of the channel. In Jeba or Great Channel they vary from West to North; at the anchorage of Bissao they are generally from S.W., except in the morning, when they are from the northward. In the rainy season, which commences here in the beginning of June, and continues about five months, they blow from the S.E., with tornados, as on the whole coast, and then, passing round by South, return to the northward.

Directions.—If from the northward, when Cape Roxo bears E. by S. ¾ S. distant about 6 miles, alter course to S. by W. ¾ W., and this made good for 20 miles will place the vessel in 8 fathoms water, in lat. 12° N.; from this position steer S.E. for about 25 miles, when Cayo Island should come in sight.*

If approaching from the West or S.W., endeavour to gain the parallel of 11° 48′ N., and by proceeding along it, E. by S. ¾ S., Cayo Island will come in sight on the port bow.

Proceeding thus, the depths will be found always regular, decreasing from 8 to 7 and 6 fathoms, when in the river channel, where the bottom is constantly of mud. It must be observed, that when entering Jeba Channel, the northern banks should be approached in preference to the southern. As the former descend by a gentle declivity, they always warn a vessel when she is out of the channel, by each cast of the lead giving a gradual decrease of depth. The southern banks, on the contrary, are extremely steep; thus, close to a depth of 7 fathoms there will be found one of 4 fathoms, on a bottom very unfit for anchoring.

In order to be assured that you are keeping the channel, keep constantly sounding, and observe, that in all the channels which separate the banks to the N.W. of the Bijougas, the bottom is almost exclusively soft mud without any mixture. At each cast, therefore, when the lead sinks into the ground, you may be certain that you are following the proper channel, and the middle of it may be found by the lead sinking deeper, and being less easily extricated. If the bottom becomes hard, it is a certain proof that you are near some bank, and if the vessel has much way on her, she must alter course directly for that side on which the bottom is softer.

A vessel running for the anchorage off Cayo Islet may pass near to the S.W. of it, this part being perfectly safe to the beach, at 1 mile from which there is a depth of 6 fathoms, on a soft muddy bottom.

Whatever may be the direction of the wind, a vessel, with the assistance of the tides, may always find her way into or out of Jeba Channel, and the working is extremely easy with the assistance of the chart, which should accompany these directions. The remark respecting the northern bank being approached in preference to the southern, should be attended to here; the islands to the northward being perfectly safe, whilst those to the southward are surrounded by very steep and hard banks. Large vessels should not approach nearer than 5 miles to the islands on the South side of the channel, as nearly all the space to the southward of this line is filled with banks, some having but little water on them, and the greater part of which lie in the channel. If it should fall calm, and it be wished to let a vessel drift with the tide, she must not be abandoned to it until she has opened the channel she intends entering.

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* Vessels coming from the northward, after making Cape Roxo, may steer S.W. from that cape, in 8 fathoms, all along, until they catch from 10 to 12 fathoms, green oaze; then steer S.E. by E., taking care not to get into less than 6 fathoms on the port hand on Cacheo Bank, &c.—*Mr. Swann, a Pilot.*

A vessel may anchor anywhere in Jeba Channel, the bottom being of soft mud and excellent holding-ground, with the exception of one place about 3 miles off the South point of Bassi Island; here the depth is irregular, from 12 to 20 fathoms, and the bottom of coarse gravel. In all other parts of the channel the depth is considerably less than this. In case of the approach of a tornado, it is advisable to anchor.

In proceeding to Bissao, when the South end of Cayo Islet bears N.E., distant 2 miles, steer S.E. for 15 miles, coasting the island of Jatt to its S.E. point, which, from the trees upon it, appears to be the highest part of the whole coast on the northern side of the channel. You will thus pass northward of Cayo Bank, and S.W. of Arlett Bank, the depths varying from 8 to 6, 9, and 12 fathoms. Arlett Point will then bear N.E., distant 3½ miles, and the course should be altered to E.S.E., for 16 miles, passing about 2 miles southward of Ancora Islets, and to a position midway between Martinho and Arriscado Banks. Off Ancora Islets the ground is very uneven, 15 to 20 fathoms, but farther eastward regular depths of 9 to 10 fathoms are found.

From mid-channel, between Martinho and Arriscado Banks, steer about East, for 15 miles, in depths of 8 to 10, 6, and 5 fathoms, the latter depth being found on the northern spit of Gancho Banks, where you may possibly pass over several patches, on which there is only 26 ft. at low water; they may be avoided by altering the course occasionally, but, as they are of no great extent, a vessel may pass over them without any fear, and may shape a direct course. This course will lead clear of Bernafel Spit, in 6 to 9 fathoms, and from here the town of Bissao, with the islands of Passaro and Rey, will be distinctly visible. Steer so as to pass within 2 cables to the eastward of Passaro, this part being extremely steep, there being, at the above distance from it, a depth of 8 fathoms. From hence run between Rey Island and Bissao, and anchor in 6 to 8 fathoms, on a soft muddy bottom. Having rounded Passaro, the coast of Bissao should be approached nearer than Rey Island, as the depth is greater, and varies from 6 to 7 fathoms.

Bissao Roadstead is perfectly safe in all weathers. It is so completely sheltered, that the sea is always smooth; and the bottom is of such a nature that with good ground-tackle a vessel may ride there in any season. It is advisable to moor N.E. and S.W., as the tides set in this direction; and in the rainy season, as the squalls come from the S.E., the anchors, being thus placed, will bear an equal strain.

It would be superfluous to mention the necessity of sounding constantly in this internal navigation.

A *Telegraph Cable* having been laid from Bissao to Bulama, anchorage is prohibited between the S.W. point of Rey Island and Bissao Fort; vessels must not pass to the N.E. of this line. The course of the cable, through Arcas, Bulama, and Bolola Channels, was marked by *buoys*, reported to be often adrift, so that no dependence can be placed on them.

BISSAO, once the great stronghold of the Portuguese slave traders, is now of little importance, but the Portuguese still maintain a convict settlement and a small garrison here, and in the vicinity is a large native town, the inhabitants of which are not to be trusted. India-rubber, beeswax, gum, and ground-nuts are exported in limited quantities, and the imports are confined to cotton goods, spirits, tobacco, guns, and gunpowder. There is telegraphic communication with Bulama, Bathurst, Sierra Leone, the Isles de Los, &c., and Europe.

The market is stated to be scantily supplied with the commonest necessaries of life; though, at times, supplies are obtainable in trifling quantities, at exorbitant rates, such as small bullocks, goats, pigs, poultry, with rice, maize, and yams, and some fruit, such as bananas, oranges, and lemons. Though the country is well wooded, fire-wood is scarce and dear, and the character of the natives and the climate prevent crews of vessels cutting it for themselves.

The watering-place is on the beach, close to the southward of the fort. It consists of several pits, about 4 ft. deep, and may afford sufficient water to fill thirty casks in twenty-hours. This water before being filtered, coming from sand and rock, is not agreeable to the taste, although it has the reputation of being wholesome, and of keeping well; nevertheless, it should not be drunk without being acidulated, or purified by other means. It may be either brought on board in boats, or rafted off at high water. Water may also be obtained at Passaro Islet.

CHANNEL of the RIO GRANDE or BOLOLA.—The Eastern Channel to Jeba River passes eastward of the Bissagos, its southern entrance being known as Orango Channel. Continuing to the northward by Kanabac Reach, Bulama Channel, and Arcas Channel, it joins Jeba River by the latter channel about 10 miles to the south-eastward of the town of Bissao. The navigation by this route is less direct than that by Jeba Channel, and the water is deeper.

ORANGO CHANNEL is bounded on the West by Orango Island and the banks and reefs stretching to the S.E., and on the East by an extensive range of reefs, on which are several islets. At its northern end it is 5 miles wide, and can be safely navigated by a stranger who pays attention to the tides, lead, and look-out. Unless the vessel's position be well determined, as a glance at the chart will show, there may be some difficulty in making this channel from sea, as on either side its approach is bordered by reefs and shoals, mostly steep-to, and far out of sight of land.

The Winds in the Eastern Channel are generally light during the fine season, particularly in the night or morning. They set in gradually in the afternoon, and blow almost always from S.S.W. round by West to N.N.W., but they remain a very short time at any intermediate point, and soon follow the direction of the land, which, as far as could be determined, trends nearly N. by E. and S. by W. Easterly winds are limited entirely to the rainy season.

The Tides are as regular in the Eastern as in the Jeba or Great Channel. The length of the ebb is equal to that of the flood; the former sets to the northward, the latter to the southward, but the different points of the channel, and the irregularities of the bottom, affect those directions. The mean rise of the tide is from 12 to 15 feet. The strength of the stream varies according to the breadth and depth of the channel, being greater where it is confined than in the wider parts; it is consequently more considerable in the Strait of Bulama, and the passage between Jamber and Mel Islands, than in any other part. Nevertheless, it seldom exceeds 2½ miles per hour, but is frequently as much as 2. At 2 miles to the westward of Pullam Island it is high water, on full and change, at $10^h\ 15^m$; springs rise 11 feet. Off the entrance the streams set N.E. and S.W., at the rate of one-half to 1½ knot an hour.

Orango Island is the largest island of the Bijouga Archipelago. Its eastern part is not very high, and is of the same nature as the adjoining islands. The most conspicuous point, when bearing N.W. by W., is a well-defined cape, much higher than the adjacent land, and remarkable from several spots of yellow sand, which form a striking contrast to the brown appearance of the coast. This cape, forming the S.E. point of the island, is called *Cape Cameleon*, or *Yellow Cape*. *Pipon Patches*, 2½ miles eastward of the cape, have depths of 1¼ to 3 fathoms over them, and about 5 miles E. ½ N. from the cape is *Bronco Reef*, about 1 mile in extent, with 6 ft. least water over it, and depths of 6 to 19 fathoms close around. *Cameleon Reefs* extend 2 miles S.S.E. of the cape, and should not be approached within the depth of 12 or 10 fathoms.

Orango Reef, on which the sea breaks heavily, extends for 10 miles to the S.W. of Cape Cameleon, with deep water along its eastern edge.

Ætna Patches, 18 miles W.S.W. of Cape Cameleon, consist of several rocky ledges, on the eastern part of which are some sand-banks dry at low water. To the southward of these are other banks and dangers, terminating to the southward in *South Breaker*, described on page 664. Vessels approaching Orango Channel from the westward should not pass northward of lat. 10° 35′ N., till well to the eastward of the meridian of South Breaker.

Pullam Island, in lat. 10° 52′ N., long 15° 43′ 20″ W., derives its name from that given by the natives to the large trees (*Bombax*, or silk-cotton), with which it is covered. It is not above half a mile in extent in any one direction, and is very little above the level of the sea; but the lofty trees render it the best landmark for the entrance of Orango Channel. Its shores are rocky, and encircled by a reef. Rocks and foul ground extend for 6 miles S.W. ½ S. from it, and 5 miles to the N.W. of and parallel with this line. *Pullam Shoals* and *Bicho Bank* extend for nearly 12 miles N.N.E. of the island, in several parts dry or breaking, and no vessel should venture among or near this dangerous labyrinth.

Mel, Cavalho, and Jamber Islands, lying on the N.E. edge of this bank, are of nearly equal height. *Mel* or *Honey Island*, 6½ miles N.E. ½ E. from Pullam Island, has some white sandy cliffs, and *Cavalho* lies 2 miles N.W. of its northern end. About 1½ mile N.W. of the latter is a long narrow bank, drying at low water, lying along the northern edge of the main bank. *Jamber* or *Yomber Island*, 2 miles in diameter, is separated from Mel Island by a narrow deep channel, which should only be used in case of necessity.

Vessels have approached Rio Grande by the channel eastward of Pullam and Mel Islands, but Orango Channel is far preferable.

From a position midway between Cavalho Island and Bronco Reef, a S.W. ½ W. course will take a vessel clear out to sea.

Kanabac Reach is about 26 miles in extent, from Orango Channel to the Rio Grande, and 2½ miles in width at its northern and narrowest part. Its eastern side is formed by the bank extending off the coast, and its western side by Kanabac Island, and the bank extending N.E. of it.

Kanabac, or *Kanayabac*, or *Roxa*, one of the largest islands of the group, is of moderate elevation, and rather higher at the southern than the northern end. It presents alternately a sandy, volcanic, and ferruginous soil. If we may judge from the numerous population, and the quantity of cattle on it, this island must be very fertile, and its climate is considered more healthy than many of the other islands. The large trees called *pullam* trees, with palms, and vegetables of all kinds, are very plentiful on it. Anchorage may be found all along its eastern side, within 2 miles of the shore, in depths of 8 to 10 fathoms.

Barel Point, the S.E. point of Kanabac, is a red rocky point, 60 ft. high, and on the opposite side of the channel, at 4½ miles S.E. of it, is a rocky islet about 10 ft. high, lying on the edge of the bank. The shallow port of *Manel*, lying between the West side of Barel Point and an islet called *Pomp*, seems to be the chief resort of the canoes belonging to the inhabitants of the southern part of the island. At 3 miles N.N.E. of Barel Point is *Damiong Bay*, where water may be obtained from a pool or by digging, but it requires filtering or boiling. Firewood may also be cut and easily shipped here.

Porcos or *Hog Islands*, off the N.E. end of Kanabac, are four little islands called by the natives *Rouban*, *Banak*, *Chieeya*, and *Corett*. The latter, which is the northernmost, is the most remarkable, being covered with large trees.

From midway between Cavalho Island and Bronco Reef, a course N.E. by E. ½ E., for 12½ miles, will take a vessel safely to abreast of Barel Point, in mid-channel, in depths from 10 to 25 fathoms, bottom of sand and shells; hence a course N.E. ½ N., for 14 miles, will lead clear to the northern end of Kanabac Reach, and the entrance of the Rio Grande, in depths varying from 8 to 34 fathoms, red sand and shells.

Bulama Channel is bounded by Bulama Island on the East, and on the West by *Gallinha Island* and the banks which extend thence to Porcos Islands and Kanabac. Enormous boa-constrictors were said to exist on Gallinha, but the island is now described as well cultivated by a peaceful people, about 600 in number. Good timber is also yielded by the forests. Between Bulama Point and Gallinha, the narrowest part of the channel, it is 2 miles in width, and from hence a mid-channel course to Kanabac Reach is S.E. by S. ¾ S., 7½ miles. This course crosses the mouth of the Rio Grande, passes along the banks to the S.E. of Gallinha, at the distance of a mile, the greater part of which is dry at half-tide, and continues to about 1½ mile from the banks on the western part of Bossessamé. The soundings on this track are very irregular, and vary from 35 to 8 fathoms, with a bottom, generally, of sand and gravel.

Arcas Channel, the narrowest and most intricate part of the Eastern Channel to the Jeba, is bounded on the East by the banks extending northward of Bulama Island, and on the West by the banks extending northward of Gallinha and eastward of Formosa and the Papagaio Islands.

Great care is necessary in the navigation of this channel; being so sheltered the dangers seldom break.* There is good anchorage in most parts of the channel, the depths varying from 4 and 5 to 12 and 20 fathoms, and boats can reach Bissao by the shallow passage eastward of Arcas Island.

It is high water, on full and change, at $10^h\ 10^m$; springs rise 11 to 14 feet. The tidal streams set N.E. and S.W., with a velocity of 2 to 3 miles an hour.

Arcas Island is nothing but a mangrove swamp, from which shallow rocky banks extend 3½ miles to N.E. and S.W., and 2½ miles to the westward. *Pedralva Rocks* lie on the opposite or western side of the channel, 7 miles N. by W. ½ W. from Bulama Point, and were marked by a *beacon*, a tripod bearing a *black ball.*

In leaving Bissao to pass through Arcas Channel, bring Rey Island just open eastward of Passaro Island, bearing N.E. ½ E. astern, which will lead clear to the N.W. of Arcas Flats and direct towards Pedralva Rocks. When St. Martin Grove (page 665) bears N. ½ E., and Arcas Island East, steer South for Bulama Point, until within 2 miles of it, when edge a little to the westward to avoid the shoal ground off it, and pass in mid-channel between it and Gallinha Island.

BULAMA, or Boolam Island, is well wooded and of moderate height, inhabited by an industrious people, who cultivate its fertile soil. Its climate is insalubrious, but between 1820 and 1838 it was a great resort for slave-traders, under Gaetano Nozzalini, of Havana, and in the latter year the factory was destroyed by H.M.S. *Brisk*, Lieutenant Kellett in command. *Bulama Point*, the western extremity of the island, had two conspicuous trees upon it; the English settlement here was abandoned in 1868. Reefs extend a short distance off this point, and a shallow bank lines the S.W. shore of the island, terminating to the southward in *Hacket Reefs.*

Dalrymple Bay, the bight of the bank between Bulama Point and Hacket Reefs, has depths of 8 to 20 fathoms, soft muddy bottom, affording fair anchorage S.S.E. of the point, but from 8 fathoms the depth quickly decreases. The configuration of the land is such, that the strength of the current, being carried more to the southward, is almost imperceptible at this anchorage; and although the tide rises from 12 to 15 ft., the sea is generally smooth and the landing easy. At this roadstead fresh water may be procured from two places on the beach.

Bolola Channel, the entrance of the Bolola or Rio Grande, is bounded on the N.W. by Hacket Reefs and the bank lining the southern side of Bulama, and on the S.E. by Manteri and Bossessamé Islands.† Here is the junction of Kanabac Reach with Bulama and Bolola Channels, and hence the latter extends 7½ miles to the N.E., and spring tides run very rapidly in it.

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* *Buoys* were moored in the northern part of Arcas Channel, off Arcas Island and Pedralva Rocks, but they are often adrift, like the telegraph cable buoys mentioned on page 668.

† *Buoys* were also moored to assist in the navigation of Bolola Channel, but no dependence can be placed on them, as they are liable to drift.

BULAMA, the chief settlement of Portuguese Guinea, is situated on the eastern side of Bulama Island, but is of no great commercial importance, being chiefly a convict station. Some small supplies may be obtained, including water, but the latter may be procured more easily from some springs near the S.W. end of Biafares Island. A telegraph cable is landed here, and vessels must not anchor near its position, which was marked by a *buoy*. According to recent observations the flagstaff is in lat. 11° 35′ 47″ N., long. 15° 28′ 50″ W.

Port Beaver, so named from Captain Beaver, who founded a settlement here in 1792, is formed between Bulama and Biafares, affording excellent sheltered anchorage, easy of approach.

BOLOLA RIVER, or Rio Grande, is said to be navigable for a distance of 450 miles, and on it the Portuguese have several establishments. There is a small trade carried on, chiefly in ivory, wax, hard soap, rough hides of every kind, dyeing and building woods, indigo, cotton, drugs, resin, and resinous gums, gold in small quantities, orchilla, &c.

Bossessamé or *Bessessema Island*, on the South side of the entrance, consists of rich alluvial soil, producing corn, kus, rice, ground-nuts, sugar-cane, yams, potatoes, vegetables, tropical and *European* fruits and flowers in abundance. M. H. Orteau, who employed about 300 natives, represented the place as healthy, and that even in the rainy season fevers seldom or never prevailed.

At 13 miles above *Lawrence Point*, the N.W. extreme of Bossessamé, is *Bissagua Island* and depths of not less than 9 fathoms will be found in mid-channel for 16 miles farther on. It then shoalens to 4 and 3 fathoms, off the settlement of *Buba*.

THE COAST, between the mouths of the Rio Grande and Componi River, is very imperfectly known, but it appears to be, in general, low, shoal, and dangerous to a great distance from shore. On the edge of the bank, in lat. 10° 37′ 45″ N., long. 15° 21′ W., and at 26 miles S.E. ¾ S. from Pullam Island, is a rocky bank, called the *Alcatraz*, with a rocky islet in its centre, 40 ft. high, and of volcanic origin. Sir Edward Belcher found no difficulty in landing on its S.E. side, and considerable numbers of eggs of the booby (*pelicanus sula*) were procured. At 1 mile to the W.S.W. is *Wreck Islet*, and both these islets are surrounded by reefs and foul ground, reaching 6 or 7 miles W.S.W. of Alcatraz, with a width varying from 2 to 3½ miles. *Alcatraz Reef*, 4 miles W. by S. from Alcatraz, partly uncovers at low water, and at 2 miles S. by W. of the islet is *Spitfire Shoal*, with only 6 ft. water over it. Fish is abundant between Alcatraz and Componi Shoals.

Cassini River.—About midway between Pullam and Alcatraz Islets are several detached patches of 10 to 18 ft., with 8 to 12 fathoms close-to, lying in the approach to Cassini River, the entrance of which is obstructed by an assemblage of sand-banks, drying in parts at low water. They were partly examined by French officers in 1857, who found a channel between them, with 3½ fathoms least water. A trading station was established on the South bank, 10 miles above the entrance, where the river is 2 miles wide with 9 fathoms in mid-channel. Between the Cassini and Bolola are the mouths of several other rivers, of which little is known beyond what appears on the chart.

Componi Shoals, to the S.S.E. of Alcatraz, form an extensive bank, terminating to the southward in *Conflict Reef*, which was surveyed and so named by Captain Owen, in 1826. Some parts of this reef are above water, and two dangerous prongs project to the southward and S.W. *West Prong* has a depth of 3½ fathoms near its extremity, at 15 miles South of Alcatraz, and at 11 miles S.E. by E. ½ E. from this is a patch of 3 fathoms on the extremity of *South Prong*. A rocky head, with only 15 ft. over it, lies 5½ miles S.W. by S. ½ S. from South Prong, and 37 miles S.E. by E. ½ E. from Cape Verga. As other similar detached knolls may lie in the approach to Componi and Nuñez Rivers, every possible precaution must be taken in its navigation.

Hereabout is the boundary between Portuguese Guinea and that section of Senegambia called *Rivières du Sud* by the French (see page 611). These rivers are the Componi, Nuñez, Pongo, Dembia, Debreeka, and Mellacoree, with other smaller streams and creeks, the French governor residing at Conakry, near the Isles de Los.

Componi River.—At 26 miles N.E. of the South Prong is the broad estuary of the River Componi, *Compoonee*, or *Cogon*, bounded on its western side by the *Tristão Islands*. Its approach is encumbered with extensive banks and shoals, partly dry at low water, and owing to frequent changes in their form and position the navigation is dangerous. Captain Belcher states that during his survey several canoes were seen at a distance, and one country schooner; from which, and the numerous fires at night, it seemed likely that the banks are well inhabited, and have some traffic. It was found that small vessels only could navigate this river without great risk, there being a chain of reefs, which nearly bars the passage; but above this barrier the channel is sufficiently deep for larger vessels, and has few dangers.* It has recently been explored by the French, and about 44 miles up it is the native town of *Kandiafara*, amid a rich and populous country; here the river is more than a mile wide, about 30 ft. deep, and can be reached by vessels drawing 13 to 16 feet.

Between the entrance of Componi and Nuñez Rivers are two other rivers, and the coast is lined with shoals, extending 13 miles off the entrance of the *Kassagua River*.

Gonsalez or *Young Gonsalez Island*, forming the South point of the approach to the River Nuñez, is the southernmost of three small islands, within which is a narrow passage to the Nuñez known as the *River Broat*. These islands are covered with tall trees, and Gonsalez may be seen 6 miles in clear weather, but they are fronted by a dangerous rocky flat, which extends 8 miles S.W. of Gonsalez. At 4 miles S.W. ½ S. from Gonsalez is a part drying 6 ft. at low water, composed of a coarse red sandstone, or conglomerate, appearing like lava, till broken.

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* Sir Edward Belcher gave a pleasing description of its course upward, for which see the Geographical Journal, vol. ii., pp. 287—288. In the upper part many indications of buffaloes, hippopotami, deer, lions, panthers, monkeys, &c., were seen. The latest accounts are by Captain Brosselard.

RIO NUNEZ, also known as the *Kakoondee*, *Kakundy*, or *Nuna Tristão*, is of considerable width at its entrance, but its source is only 50 miles inland. On its banks are several French trading stations, and at one time it was celebrated as a place of trade for ivory. *Victoria* or *Ste. Eugénie*, 13 miles up the river, is the chief settlement, and here supplies of cattle and sheep may be obtained, but water can only be had from the river. Coal may be procured at *Belair*, and there is regular communication with Sierra Leone by means of a small steamer.*

The Climate is very unhealthy, especially in winter, when there is much foggy weather; November and December are the worst months. The rainy season is from May to September, and at this time tornados are frequent and violent; but, with caution, vessels may have sufficient time to prepare for them. Capt. Livingston observed none here to begin with small clouds, but all with heavy thunder clouds. The range of the thermometer, while the *Ætna's* boats were in the river, March and April, 1831, was at 6 a.m. from 75° to 84°; at noon, 84° to 94°; and at 9 p.m., 81° to 83°. The dews were slight; but at other seasons are said to be very heavy.

Like the other rivers on this coast, the Nuñez is encumbered with shoals in its entrance, which are liable to change, but a least depth of 3 fathoms will be found in the main channel. *Talabuncha Point*, the North point of the entrance, is elevated and thickly wooded, and has a drying sand-bank extending 2 miles S.W. of it.

On the bank in the middle of the entrance is *Sand Island*, in latitude 10° 36′ 37″ N., long. 14° 41′ 10″ W., which does not appear on the old charts. Where Woodville gave a shoal, Capt. Livingston, in 1829, found an island of considerable size had arisen within 30 or 40 years, covered with trees of various kinds. In 1831, Captain Belcher describes it as at least 6 ft. above high water, and bearing large trees, of which the palm yields an excellent cabbage,† and added that a very extensive range of shoal water had formed on its North, West, and S.W. sides. He considered that, for a vessel to refit, no place could be better adapted than Sand Island, there being space sufficient to encamp the crew of a line-of-battle ship, and stores could be conveniently landed. However, in 1885, it was merely a low sandy flat, nearly level with high water, with a clump of mangrove near its centre, and only frequented by water-fowl. There is good anchorage in 7 fathoms, off the S.E. side of Sand Island, with the island in line with Talabuncha Point, bearing N.W. by W.

At 5 miles E.N.E. of Talabuncha Point is a village, the situation of which, according to Capt. Livingston, may be known by some remarkable large trees, visible from seaward for a distance of 14 miles in clear weather. He says he had heard it remarked, that wherever you see a large clump of majestic pullam trees (the cotton-tree of the West Indies) you are sure to find a negro village; and wherever you meet with a palm tree, you may be sure of finding fresh water, by digging a few feet deep, however arid the soil may appear. He also advised that no person ought to land at Talabunch unless in company with eight or ten others, well armed, and on their guard; but on the opposite or eastern side, *Talabunchana*, the negroes, though of the same tribe, were remarkably civil and honest.

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* In "Le Tour du Monde," 1886, pages 273—304, is an interesting article on the Nuñez, by Lieut. A. C. de Nordeck, French Navy, entitled "Voyage aux pays des Bagas et du Rio-Nuñez," from which we have taken some particulars.

† This cabbage makes a delicious pickle, considered one of the finest anti-scorbutics in the world, doubly valuable when other vegetables are not to be had.—*E. B.*

The descendants of the Portuguese, who still exist on the banks of the Rio Nuñez, are so mixed with the negroes, that they have been described as negroes themselves.

Directions.—Vessels from the northward, bound to the Nuñez, should endeavour to make Alcatraz Island, and from thence steer so as to sight the breakers on the South Prong of Conflict Reef, not bearing away to the eastward till in lat. 10° 20′ N. at the highest. From a depth of 9 fathoms, midway between South Prong and the rocky head of 2½ fathoms, an East course will make direct for Gonsalez Island, with very irregular soundings.

If from the southward, the high land of Cape Verga will form a good mark in clear weather, for avoiding the dangerous ridge westward of it.

When Gonsalez Island bears East, distant about 5 miles, a N.E. ¾ N. course will lead towards the entrance of the river, but strangers should procure a pilot for the river, by sending up to Victoria, or one may sometimes be had from a coasting vessel. It is necessary to remember, with a flood tide, that there is a dangerous rocky flat on the starboard beam going in, while, on the other hand, a vessel may approach the edge of the breakers on the Sand Island flat on the port side. The constant warning, also, "Keep in mud," which is familiar in all river channels along this coast, should be here especially kept in mind.

A steamer drawing 14 ft. can safely enter, and according to the latest charts, when Gonsalez bears S.S.E., distant 4¼ miles, a N.E. by E. course, for 6 miles, will take the vessel abreast of Sand Island, where she may anchor in 6 or 7 fathoms, or proceed N.E. ½ N. to abreast of Talabuncha village. Then keep in mid-channel, passing close to *Big Island*, where a rocky spit projects from the western shore. At 3 miles above Big Island is the settlement of Victoria, previously mentioned. The tides are said to run 4 or 5 knots an hour at times.

Above Victoria the river becomes very winding, and the trees on either side impede the wind in its true course. Still, however, a pleasant, and after noon, even a fresh breeze generally favours vessels bound up, and affords favourable slants in many of the reaches down. The general depth may be stated at 2½ to 3 fathoms at low water, with a rise and fall of about 12 ft. Although the lead generally gives mud, the anchor frequently hooks a rock, and good and long buoy ropes are especially necessary, which should be got on board the instant the tide slacks, in order to be in readiness to trip the anchor instantly, if found to be foul. The change of the tide is very rapid, and much inconvenience will be felt if completed before breaking ground. On going up the Nuñez in a boat, be cautious not to mistake any of the creeks on the western side for the main river.

Ropass or *Rappace*, about 10 miles above Victoria, is another settlement, and by keeping in mid-channel not less than 3 fathoms water will be found up to it. Here a rocky barrier reaches off the South shore, described by Capt. Livingston as ridges of rocks, almost like walls, and which appeared from a boat, at low water, like walls of lava, extending about two-thirds across the river. At about 1 or 1½ mile above that, it is said that rocks, even worse, spit out from the starboard or eastern shore; but these were not seen in passing, when covered with the tide.

H.M.S. *Grappler*, in 1858, ascended 10 miles above Ropass to *Kasasi* or *Cassassez*, at 2 miles below which is *Walkeria*, so named from Walker, a slave factor, who realized a large fortune and died here. In 1828, this place was composed of thatched huts, mostly supported on stakes, though some had mud walls, and there were two of two stories each. The population numbered from 500 to 600, who were all Mandingo Mohammedans, excepting the slaves. The wharf is in about latitude 10° 53′ N., long. 14° 17′ 30″ W.

Above Kasasi the river is much interrupted by rocks of close-grained basalt, several of them presenting a perfect columnar formation. *Boké*, *Debucko*, or *Rebucko*, a trading station about 5 miles above Kasasi, may be reached at high water by vessels drawing 10 ft., but even boats cannot proceed far beyond this.

Captain Belcher says they had formed great expectations of the supplies which could be procured at these settlements, but were much disappointed. Bullocks and sheep could be procured with some difficulty; fowls were very scarce; and vegetables could not be got at all. These native towns are never prepared to meet a sudden increase of demand for food. Of rice alone they seem generally to have a superfluity.

Capt. Livingston also remarked that vessels going to the Nuñez ought to be well supplied with provisions, and not to depend on what can be obtained there, as a great scarcity frequently prevails. There are many cat-fish in the river, and above Rebucko some other kinds of fish. There are pike, similar to those of England, but with much larger scales.

There was very little cultivation on the Nuñez, with the exception of a variety of rice which requires no artificial irrigation. Fruit is scarce, but when the rainy season sets in, the *locust* tree ripens its bean-like pods, much used for food. Monkeys abound in the forests, and alligators in the river. Both banks of the Nuñez are generally muddy; mangroves grow into the very water, and some of the finest tree or mangrove oysters adhere to their trunks and branches.

Tides.—At Sand Island it is high water, on full and change, at 10^h; springs rise 15 ft., neaps 11½ feet. Capt. Livingston states, from his observation, that it is high water at Walkeria, on full and change, at 10^h 17^m a.m., with a rise of 16 to 18 ft. or more. He says the tide here runs strongly, and while there it flowed five hours and ebbed seven; but during floods in the river (which sometimes rises considerably) it ebbs or runs down longer. In February, 1848, the officers of H.M.S. *Grappler*, when at Kasasi, found the tide flowed 4 hours and ebbed 8 hours, the rise being about 8 feet.

The Coast from the Rio Nuñez to Sierra Leone, in an extent of about 150 miles, is in general low, in most parts swampy, and intersected with creeks, which, connecting the adjoining rivers, form an excellent boat navigation. At distances varying from 5 to 20 miles inland, the land rises gradually; and beyond that distance, in many places, towers into lofty mountains, which, after a tornado, when the air is pure, may be seen 30 or 35 miles off.

At about 5 miles E.S.E. of Gonsalez Island is the entrance of the *River Coppatches* or *Kappatches*, off which there are breakers at a distance of 4 miles. This is a trading river, but shallow, and frequented only by boats, or vessels not drawing more than 4 ft. of water.

CAPE VERGA, 21 miles S. by E. ½ E. from Gonsalez Island, and in lat. 10° 11′ 30″ N., long. 14° 28′ W., is very conspicuous, being a rocky point projecting from the mangrove-lined coast on either side. Within it the land rises into a range of moderately elevated hills, and two conical hills, about 1½ mile northward of the cape, are visible 13 or 14 miles, when bearing East. About 9 miles N.E. of it will be seen an isolated mountain, with two summits, rising to a height of 3,000 ft., according to M. Roussin, and said to be visible 45 miles in clear weather.

Verga Ridge.—Between Gonsalez Island and Cape Verga the coast forms a wide but very shallow bay, which no vessel should attempt to enter. At 7½ miles W.N.W. of Cape Verga is the southern end of a long narrow ridge, which extends N.E. by N. to the coast, with 7 ft. least water on its outer part, and less farther in. Vessels must beware of becoming embayed in the bight on either side of it.

To the S.E. of Cape Verga the coast again becomes low and swampy, appearing to consist of a series of mangrove islands, liable to constant changes. It is fronted by a shallow bank, the 3-fathoms line being found from 3 to 7 miles off the shore.

RIO PONGO, or Ponga.—This river is of considerable size, and of some importance commercially; in former times, slave-trading was carried on here to a great extent.* It is approached by several entrances, or inlets, but all seem to be included under one general name, *Pongo* or *Pongas;* each is impeded by a bar of mud or sand; and the banks, to the heads of the several rivers, are entirely covered with mangroves. No stranger should attempt to enter without a pilot, as the shoals are constantly changing.

The first of the *Pongas*, or entrances to the Rio Pongo, is about 13 miles S.E. ¾ E. from Cape Verga, and is called the *Cossencey* or *Common Bar*, having a shallow and dangerous entrance, though within there is 4 and 5 fathoms of water.

Mud or Rissing Bar, 17 miles south-eastward of Cape Verga, is the best channel in for small vessels or a stranger, being marked by constant breakers on either side. The bottom is very soft mud, and, if no pilot can be had, vessels drawing less than 15 ft. may venture in at three-quarters flood. The flood sets directly in, but the ebb sets across the eastern bank. When over the bar, the channel narrows to 1 mile between Goru and Jilli Points; *Goru Point*, on the North, had two rows of palms on it, and *Jilli Point*, which terminates rather abruptly, had some bushes on it. From the bar, two hills up the country, called the *Paps*, bear about E.N.E., and serve as a mark for it.

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* A good account of this river is given in the "Révue Maritime et Coloniale," 1885, pages 26—32, from which we have taken some particulars.

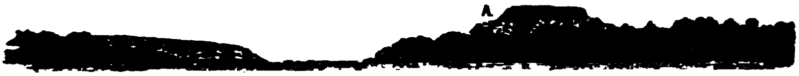
At 8 miles S.W. ½ W. from Goru Point, the depth is 4 fathoms, and a N.E. ¾ E. course from hence will lead clear in, the least depth on this course being about 4 fathoms at high water springs.

Captain Belcher, who surveyed the river in 1830, directed that to sail over the Mud Bar, get the river open, and steer in N.E. by E., keeping the Paps, which are moderately high, a cable's length open of the North point, by which you will carry 4 fathoms at high water, or 2 fathoms at low water. If going in, with a fair wind, bring the North point of the river, with its palm trees, to bear N.E., and run in with it bearing N.E. by E. On entering, keep on the South side, within the bar, as the flood tide sets on the northern breakers. If beating in, stand no farther to the northward than to bring the two hills in the middle between the two points of the river; you can stand to the southward to 2 and 2½ fathoms. In the night, do not approach within the depth of 4 or 5 fathoms.

When over the bar, anchor in 7 or 8 fathoms, in the middle of the river, abreast the palm trees on the port hand, which trees appear to extend about 2 miles in length. Then send your boat up the river for a pilot, or fire a gun twice or thrice, at intervals of about an hour, and in all probability a pilot will come off to you. The river hence runs about N.E. by E., for 6 miles, and its depths, in mid-channel, are 3, 4, 7, 6, and 5 fathoms.

Sand Bar, 7 miles south-eastward of Mud Bar, though the main entrance of the Rio Pongo, and used by large vessels, is more intricate in its navigation, and therefore should not be attempted without a pilot. At low water it appears to be an almost continuous line of breakers, but, in fine weather, vessels drawing less than 15 ft. can enter at three-quarters flood. A steamer of 1,500 tons has entered the river by this route. It is high water, on full and change, at $7^h 30^m$; springs rise 12 ft., neaps 9½ feet. The streams run 1½ to 2½ knots an hour, stronger during floods, and set obliquely across the entrance, the flood to the northward.

In the best channel the depth is said to be 14 or 15 ft. at low water, deepening within to 4, 5, and 8 fathoms, where the river entrance is less than 1 mile wide. On the northern side, about 1¼ mile outside Observation or North Point, a small sand-bank just showed above high water, and mangroves having taken root on it, the bank consequently increased, and the natives planted palm trees on it.



Sand Bar of the Rio Pongo, N.E. by N. ½ N.—A. Mount Mayondi.

If necessary to enter without a pilot, bring Observation Point to bear about N.E. ½ E., keeping it so till the low-water depth of 16 ft. is attained, when alter course to about N.E. by E. ½ E., with the N.W. shoulder of Mount Mayondi open North of Murura or South Point, and this will lead over the bar up to the entrance, but a good look-out must be kept for shifting sandy knolls.

Vessels bound to the Pongas sometimes make the high land of Cape Verga, and sometimes go to the Isles de Los for a pilot, although one is not always to be found there. Some run in by their latitude, taking care to sound frequently, as soundings extend 80 miles off shore to the 100-fathoms line. In clear weather, *Mount Mayondi* or *Barkia Hill*, 6 miles eastward of the entrance, forms a good mark; it is a remarkable flat-topped conical hill, 1,300 ft. high, the most conspicuous of a range. Vessels can anchor off either entrance, in any convenient depth. In October and November the current here has been observed to set N.E. and E.N.E. for several days in succession.

Bangalong is 21 miles up the river from the Sand Bar entrance, and there is a least depth of 2 fathoms, at low water, in the channel up to it, but this town is now of little importance. Vessels can reach it with careful navigation. To the northward is a range of hills named *Suzies* or *Zozos*. *Boffa* or *Dominghia*, about 14 miles below Bangalong, is the chief French settlement, and on the opposite side of the river rises Mount Mayondi. Few supplies are to be had, and fresh water is scarce, but wood can be cut at Observation Point. The exports consist of kola-nuts, palm kernels and oil, ground-nuts, rice, skins, beeswax, gold dust, and ivory. The climate is fairly healthy; July, August, and September are the wettest months.

From Sand Bar a low mangrove-lined shore extends 21 miles S.E. ¾ S. to the mouth of Dembia River, all fronted by a wide shallow bank. At 8 miles from Sand Bar is the large native town of *Taburia* or *Tobbory*, the residence of the chief of *Cobo*, on the southernmost of the Pongas, known as the *Taboury* or *Old Ponga;* its position may be known from sea by the high cotton trees near it. Dangerous breakers here extend 1 mile out, and the bar can only be passed by large canoes.

Dembia or Brameya River branches into two arms about 9 miles from the sea, the islands between being known as *Konebombi*. The entrance of the northern arm is only navigable for boats, being blocked by a great mud-bank partly dry at low water, and reaching 4 miles to seaward. The southern arm runs into the head of Sangaria Bay, with which it is described.

Sangaria Bay is the large bight formed between Konebombi on the North and the mainland on the South, being 12 miles in width at its entrance. The coast is intersected with creeks, and the bay is all shallow, with a channel of 2 to 2½ fathoms at low water in its central part, shoaling to 6 and 7 ft. at its head. In approaching the bay, when in depths of less than 10 fathoms, the lead will sink deeply into a bottom of soft blue mud, and in 5 fathoms the water is sometimes very muddy.* No vessel drawing above 6 ft. should venture within a line drawn from Tumbo to Alligator Point. Vessels drawing 15 ft. should not, when working up along this shore, do more than open Crawford Island; and, to ensure good room, should even tack when the East End of Tamara opens of the South end of Factory Island. Westward of this bearing the soundings are very regular, and nowhere less than 5 fathoms.

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* In December, 1884, this bay was visited by the German cruiser *Ariadne*, and the remarks of the officers on its navigation, and that of its rivers, are published in the "Annalen der Hydrographie," 1885, pages 321—328, to which we are indebted for part of the information here given.

The southern arm of the *Dembia* is navigable for vessels drawing 16 ft. as far as the town of *Brameya* or *Bumia*, about 15 miles above the junction of the two arms, and beyond this the channel is barred by falls. Beyond these the river is said to be navigable for 160 miles by vessels of 10 ft. draught. At Brameya there are English and French factories, in connection with those on the Debreeka, communication being kept up by boats and steam-launches.

Jatia River flows into the southern arm of the Dembia, and at 6 miles up it is the native town of *Jatia*, the residence of the chief of *Kabilai*, accessible to vessels drawing 10 feet.

Debreeka or Sangaree River runs into the N.E. angle of Sangaria Bay by two branches forming *Coppera Island* between them. The southern branch can be used by vessels drawing less than 10 ft. at all times of tide, but the northern branch is only navigable after half-flood. Above Coppera is the settlement of *Debreeka*, where there were English, German, and French factories in 1888, carrying on trade with caravans bringing india-rubber, gum, hides, ivory, &c., from the interior. Cattle and sheep could be obtained here, and fish is plentiful in the river. Above Debreeka the river is only navigable for boats.

Sumba Paps, the *French Mountain*, or *Tikit-chin*, 1,700 ft. high, are the highest point of the range of high land along the eastern side of the Dembia. They lie about 12 miles East of the northern entrance to the Dembia, off which they are easily recognised in clear weather.

Mount Kakulima or *Suzos*, 11 miles S.S.E. of Sumba Paps, and 2,900 feet high, is the highest point of the *Sangaree Mountains*, a conspicuous volcanic range. It is situated about 4 miles S.E. of the Debreeka factories, and has a regular conical peak, excepting that, on its southern side, at half-way up, there is a large protuberance. This insulated mountain, in lat. 9° 45′ N., long. 13° 28′ W., is a certain mark for the Isles de Los during the rainy season. In the dry season the atmosphere is always so hazy, that the coast of the continent is seldom seen, even near these islands; but in the rainy season every shower clears the atmosphere, and the most distant objects may be discerned.

From the mouth of the Debreeka the low wooded coast, intersected with creeks, trends 14 miles S.W. to *Tumbo Point*, forming the S.E. side of Sangaria Bay, and about 2 miles inland is a range of hills, parallel with the coast. Off Tumbo Point lie the Isles de Los, described hereafter.

Directions.—If bound up Sangaria Bay to the Debreeka, bring Mount Kakulima to bear about E. by S., and proceed on that course so as to gain the depth of 4 fathoms by half-flood; when abreast of Alligator Point, the North point of the bay, and about 2 miles distant, alter course to E. by N., which will lead into the entrance of the river, the depth decreasing from 18 to 9 and 7 ft. at low water.

If bound to Brameya, when *Creek Point*, on the South side of the entrance to the Debreeka, bears S.E., distant about half a mile, alter course to N. by E. ¾ E., which will lead into the river, clear of the bank extending westward of *Bora-Banki Island*. At low water the depth in the entrance is only 6 ft., where the sea curled.

ISLES de LOS, or Ilhas dos Idolos, under English rule, form a group lying on the parallel of 9° 29′ N., consisting of three moderately high wooded islands, several islets, rocks, and reefs. They all lie within a radius of 10 miles from the coast, and are of volcanic origin, being formed chiefly of hard blue and iron-coloured lava, with occasional masses of porphyritic hornstone of different elevations.* The islands are densely wooded. Of the vegetable productions, the most remarkable are the palms, which furnish oil and wine, the silk-cotton tree, and a tree, the bark of which is an excellent bitter. The natives, numbering 1,300 or 1,400, belong to the tribe named Baocas or Barkas (Bagos ?), who also occupy other islands along the coast. A great similarity exists between their language and that of the tribes inhabiting the banks of the Nuñez.

The Climate, in general, may be said to be healthy, though the rainy season lasts from April to December. It is thus described by Captain Belcher. About the 8th or 10th of January the *Harmattan*, or cold strong easterly winds, continue, with some strength, for about a week or ten days; after which, the land-wind and sea-breeze take place till about the middle of February, when the wind becomes continual and N.W. or N.N.W., till the last full or change of the moon in March. Tornados generally begin and prevail, more or less, till May or June; then the rains set in, and are almost continual all July and August; they begin to abate in September, and go off in October, giving place to Tornados, which continue till about Christmas. During the rainy season the winds are mostly between South and West, or in the S.W. quarter; and the Tornados always blow with prodigious force from the E.S.E. or thereabout, accompanied with thunder, lightning, and a deluge of rain. When a Tornado has happened in the night, it is impossible to imagine the clear state of the atmosphere next morning; we have nothing like it in Europe.

Tamara, or *Footabar*, the largest and westernmost of these islands, is 5 miles in length, N.E. and S.W., by 1 mile in width, but its southern part is very narrow. It is, in shape, like a crescent, with its concavity to the S.E., forming several fine anchorages, with depths of 6 to 3 fathoms, at low water. It rises on both sides from the sea by a gentle ascent, to a moderate height, and is covered with good timber trees; the summit of its northern part is 465 ft. above the sea, and, in fine weather, may be descried at the distance of 20 or 25 miles. On approaching, it appears like a range of hills, thickly wooded, with the northern part higher than the South. There are three villages on the S.E. side, and a spring of fresh water near that on the N.E. point, where 80 hogsheads may be obtained in 24 hours; but it cannot be embarked after three-quarters ebb, and in the rainy season the swell at the anchorage renders watering with boats dangerous.

The western coast of Tamara is bold-to, and may be approached safely, but the N.E. end is fronted by a bank, and *Arethusa Reef* extends about 3 cables off the North point. A rocky bank extends half a mile East of the South end of the island, and near its eastern edge are two high rocks.

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* It is reported that the compass needles have sometimes been deranged in the vicinity of these islands.

Coral Islet lies 1¼ mile S.S.E. from the South point of Tamara, with depths of 5 to 9 fathoms between. At 2½ cables S.E. of this islet is a small but dangerous reef, with 5 to 7 fathoms close around it.

Factory Island, or *Idolos*, appears to form with Tamara the rim of a shallow crater, about 5 miles in diameter, from the centre of which rises Crawford Island. Factory Island, so named from the English factory established on it, is 4⅛ miles long, N. by E. and S. by W., varying from 100 yards to three-quarters of a mile in width. Its western side is concave, and forms the eastern boundary of the roadstead, which, during the dry season, is very safe; but, in the tornado and rainy season, there is no security, unless in the goodness of anchors and cables. At each end of the island is a wood-crowned hill, which, when seen from the offing, appear like two islands; the northern and higher one is 460 ft. high. There are some villages on the island, and the Factory, a white house with a red roof, is situated near the centre, on its eastern side, where there is good landing at a small stone jetty. Fresh water is obtained from a spring under North Peak, about 1½ mile northward of the Factory, and there is another near the S.E. extremity of the island.

Kid and *White Islets* lie on a rocky bank W.S.W. of the southern end of Factory Island, from which it is separated by a narrow channel. They are both covered with trees. *Cooper Rock*, awash at low water, lies 6½ cables E. ½ S. from the South point of Factory Island, with depths of 3¼ to 3¾ fathoms extending 2½ cables eastward of it.

Crawford or Rooma Island, also known as *Françoise*, lies midway between Tamara and Factory Island, the observation spot at the head of the bay on its North side being in lat. 9° 27′ 24″ N., long. 13° 48′ 30″ W. It is over 1 mile in extent, East and West, and rises to a height of 300 ft. at its western end. A sunken rock lies 1½ cable off the S.W. point, and a rock above water close off the N.W. and S.E. points. A shoal sandy flat extends from it towards the North end of Factory Island, apparently leaving only a narrow shallow channel near the latter. In 1885, H.M.S. *Alecto* was safely laid aground on this bank, for the examination of her rudder. The seine may be hauled here successfully.

The anchorages eastward of Tamara can be approached either from the northward or southward, the depth shoaling gradually in both channels, decreasing from 8 and 7 fathoms at the entrance to 5, 4, and 3 fathoms farther in.

North Channel is 1½ mile wide, and will be safely entered by not approaching within 3 cables of the entrance points. *South Channel* is 1¾ mile wide, but vessels must not approach within half a mile of the South end of Tamara, to avoid the rocks East of it. If passing eastward of Coral Islet, beware of the sunken rock 2½ cables S.E. of it.

Directions.—In approaching the Isles de Los, the lead forms a good guide, the soundings being regular, with good anchorage nearly everywhere. In clear weather, the high lands of Cape Verga, Sumba, and Kakulima act as good landmarks for vessels approaching from seaward.

To enter *North Channel*, bring North *Hill* of Factory Island to bear S.E. by S., and this will lead clear of Arethusa Reef. When Coral Islet comes just open westward of Rooma, alter course to S.W. with this mark on, until the N.E. point of Tamara bears North, when a S.W. ¾ W. course will lead through, clear of Crawford Shoals.

South Channel is entered by bringing North *Peak* of Factory Island just on with the N.W. extreme of Rooma, N.E. by E. ¾ E., and when between the South point of Tamara and the S.W. point of Rooma the course may be altered more to the northward for the anchorage.

The usual anchorage is in 5 fathoms, about 1 mile North of the S.W. end of Rooma, but vessels can anchor as convenient, the least depth in mid-channel between the islands being 3½ to 4 fathoms at low water.

Tides.—It is high water at Rooma, on full and change, at 6ʰ 35ᵐ; ordinary springs rise 13 feet. The flood stream sets N.E. and the ebb S.W., 1¾ knot an hour, so it is advisable to enter by North Channel with the ebb, and by South Channel with the flood.

Tumbo Island, under French rule, is so connected with the coast by beds of sand and rock, mostly dry, that it can scarcely be considered as an island; at high water the narrow channel is only navigable for canoes. Tumbo is 2 miles long, E.N.E. and W.S.W., and is flat and rocky, but is of some importance from the factories on its western end.

Conakry or *Konakri*, the residence of the French governor of the Rivières du Sud, and where there is also an English factory, is situated on the North side of Tumbo, and at *Bulbineh*, on the South side, is a German factory. Cattle, sheep, and small quantities of poultry, eggs, and fruit may be obtained here, but water cannot be depended on. Coal may also be sometimes procured at Conakry, this being a port of call for the mail steamers and other vessels trading with the neighbouring rivers. There is telegraphic communication with Sierra Leone, Bathurst, Senegal, and thence, viâ Tenerife, with Europe; the cable leaves the island in a north-westerly direction, passing about 2 miles northward of the other islands, and its direction was marked by *buoys*.

Tumbo Channel, between Tumbo and Factory Island, is 2 miles wide, but only suitable for vessels of moderate draught; the least depth in it is only from 2 to 3¾ fathoms at low water, mud bottom, affording good anchorage, but the tide runs strong. It is always advisable to pass outside the islands, unless bound to Conakry. Sailing vessels drawing 12 ft. may safely use Tumbo Channel with a favourable tide, and the mail steamers, drawing about 19 ft., also use it. The deeper water appears to be on the eastern side, but avoiding the rocky ledge extending half a mile off the S.W. part of Tumbo. Vessels drawing 12 to 16 ft. anchor off Conakry as convenient, the latter lying about 1½ mile off; but those drawing more than 16 ft. must keep farther off, in 4 to 5 fathoms, off the North end of Factory Island.

Vessels are advised to procure a pilot for the anchorage, as this district has not been closely examined. With this assistance vessels may anchor in not less than 23 ft. at low water, about 2 cables North of Conakry jetty. *Buoys* are occasionally placed to facilitate the navigation, but no dependence can be placed upon their being in position.

Tides.—It is high water at Conakry, on full and change, at 6ʰ 37ᵐ; springs rise 14 ft., neaps 7 feet. The tides are very regular, but the streams are not so. The flood comes from the S.E., runs round Tumbo Point, and then N.E. through the port, attaining a rate of 3 knots at springs. There is an eddy inshore.

To the north-eastward of Tumbo the main land rises gradually, and partakes much of the features of the Isles de Los. The whole interior is mountainous, as described previously on page 681.

Directions for Sailing from Cape Roxo to the Isles de Los.

Founded on those by the Baron Roussin.

The description of the Bissagos, already given (page 667), points out the course to be steered in order to double their S.W. extremity. A vessel starting from a point 15 miles to the westward of Cape Roxo, which will be a little without the meridian of 17° W., and thence steering S. by W. ¾ W. along this meridian to the parallel of 10° 45′ N., will pass outside of all the dangers. From hence a course of S.E. ¼ E., for 204 miles, will lead her to the North point of Tamara Island. On the latter course the soundings will never be under 14 or 15 fathoms, until near the shore of the island; and those on the first course will not be less than 7 or 8 fathoms.

From the parallel of Cape Roxo to that of the Western or Bijouga Breaker, 11° 31′ N., at a distance of 3 miles to the westward of the meridian of 17° 0′, the depth on this course will increase from 7, 8, and 9 fathoms on the Great Jeba Flat to 12, 15, 18, and 30 fathoms southward of it, and the bottom be entirely of mud. This may be depended on to show that a vessel is not far to the southward of the parallel of the Jeba or Great Channel; from this point, as far as the parallel of 10° 45′ N., the bottom is nearly free from mud, and on passing to the southward of the parallel of 11° 20′, very slight traces of it remain, but are succeeded by a bottom of fine white sand, sand and gravel, sand and broken shells, with a depth increasing from 12 to 30, 50, and 90 fathoms.

The S.W. edge of the Bissagos follows a gentle curve from the Western Breaker as far as the southern one, that of La Bayadère. The bottom, in this part, presents a singular peculiarity; amongst the fine white sand, sand and broken shells, sand and gravel, of which it is most frequently composed, a greenish-coloured sand is sometimes found. The depth decreases very gradually from 50 to 9 fathoms, from S.W. to N.E., towards the edge of the bank.

The remainder of the course to the Isles de Los passes over deep soundings, as much as 90 fathoms at the point of departure, in 10° 45′ N., and the least depth is 12 or 14 fathoms. No precise rule can be given as to the changes in the depth along this track, nor as to the various nature of the bottom. It is known only that the ground, in the space passed over by this course, seems to be furrowed with channels, which, commencing from the southern extremity of the Eastern Channel of the Bissagos, diverge toward different points between *S.W.* and *S.S.E.*, *true*. These furrows appear to have been caused by the regular tides in the mouth of the Rio Grande. With respect to the nature of the bottom, M. Roussin says that he remarked the total absence of mud. The bottom is of fine sand, in some places mixed with broken shells, small pieces of brittle rock, and gravel, which appeared to be only a covering to beds of a whitish volcanic sandstone, into which the lance penetrated but 3 or 4 inches, and did not hold. A muddy bottom is not found until about 30 miles to the westward of the Isles de Los, and then only in small quantity, till within a very short distance to the N.W. of those islands.

Tides.—In proportion to the distance from the mouth of the Jeba or Great Channel of Bissagos, either to the northward or southward, the tides lose their regularity. The interruption in the tides is evident in going to the southward, as, at a few miles South of the parallel of the Western Breaker, 11° 31′ N., they are no longer perceptible, even on the edge of the Bissagos Bank.

BETWEEN THE ISLES DE LOS AND SIERRA LEONE, an extent of 66 miles, the low wooded coast is intersected with several rivers and creeks, all fronted by shallow banks, on which lie several small islands. In approaching this part of the coast it may be remarked, that though the 3-*fathoms* boundary, in some places, extends to a considerable distance, yet the soundings are so regular as to give ample warning. A tumbling sea, at times, may prevail in a strong breeze, yet as no gales but the *Tornados*, which are of short duration and off shore, are known upon this coast, a commander need never be alarmed; for there is always good anchorage under foot, and no long swell current to force the vessel into danger.

Between Tumbo Point and Matacong Island, 21½ miles to S.E. by S., the land falls back 7 miles to the N.E., forming an extensive but shallow bay. The 3-fathoms line follows the trend of the coast at a distance of about 6 miles, and thence it gradually deepens to seaward, affording good anchorage, and no detached dangers are known. Vessels may thus safely approach this coast according to their draught, sufficiently near to distinguish the land, and often to recognise the mouths of the rivers. At 8 miles E. ½ N. from Tumbo Point is the mouth of *Tannaney* or *Tanneneh River*, an inconsiderable stream only accessible to canoes.

Manea River, about 12 miles E.S.E. from Tumbo Point, is at low water scarcely accessible to the smallest coasting vessels, but the rise of tide is 11 feet. The entrance is about 6 miles south-eastward from that of the Tannaney, but the water between is very shallow; a mud-bank, which extends south-westward from the West point of the entrance, uncovers at low water for more than 2 miles from that point. A similar mud-bank lines the East side also, leaving the channel between above a mile wide, but carrying only from 4 to 8 ft. at low water. The quantity of water discharged from this river must be very great, as the ebb tide runs out with great rapidity.

To enter this river, it is only necessary to bring the western point of the entrance, while at the distance of 5 miles from it, to bear N.E. by E. ½ E., and then steer towards it in that direction, until close to the northern mud-bank, when you may proceed along by the edge of that bank, in a convenient depth, according to circumstances. Within the river the depths at low water are from 6 to 10 ft. only.

River Morebiah, or Morebaia.—The mouth of this river is about 18 miles S.E. ½ E. from Tumbo Point, and 7 miles N.N.E. of Matacong Island; and, though its breadth inside nowhere exceeds half a mile, yet it is far superior to the Manea. The entrance channel over the bank is narrow, and forms an elbow, to render which perfectly safe, would require two buoys, because the coast is destitute of good objects to serve as marks.

In approaching the coast abreast of the river, with its opening bearing E. by N. ½ N., distant about 9 miles, and Matacong Island S.E. by E. ½ E., you will have 6 fathoms of water, over black mud; from this position, on a course E. by N. ½ N., the depth will decrease gradually, over a bottom of the same kind, to 3½ fathoms at the entrance of the channel. With the rounding of the land between the Rivers Manea and Morebiah bearing N.N.E., the S.E. point of the entrance E. ¾ N., and the middle of Matacong Island S.E. by S. ½ S., you will have that depth. From this position steer N.E. by E. ½ E. until the S.E. point of the river entrance bears E. ½ S., and then stand in towards this point, or about East; but remembering that both flood and ebb set partially over the extensive shoals which form the South side of the channel. Some of these, however, being dry at low water, and nearly so at high water, their steep boundary is easily discernible. In the elbow of the channel the least depth is 1½ fathom at low spring ebbs; this depth, however, continues but a short distance, and, from the time of altering your course to the eastward, or steering straight in, you will seldom have so little as 2 fathoms. Within the points the depth varies from 4 to 6 or 8 fathoms, and for the extent of 7 miles up the river it appeared to be clear of all danger.

About 3 miles within the entrance, and on the East side, is a remarkable round mass of granite rock, rising abruptly about 40 ft. from the water's edge. It is about 400 yards in circumference; others may be seen inland, and the natives assert that several are scattered about as far as the Suzos Mountains, which, they say, are also of granite.

It is high water, in Manea and Morebiah Rivers, on full and change, at $7^h\ 40^m$; spring tides rise 11 feet.

The contrast which this coast presents to the eye, in different states of the atmosphere, has been already noticed in pages 166 and 681.

MATACONG ISLAND is about 1 mile in extent W.N.W. and E.S.E., with a large rock more than half a mile off its West side. The island possesses a spring of good water, and the luxuriance of the trees, the verdure of those spots which have been cleared, and the gentle rise, render it a conspicuous contrast to the low swampy tract opposite. It appears to consist of lava, yet on its summit there are two large slabs of granite; but there is reason to believe that they have been artificially placed there, by Portuguese slave-traders according to the natives. In 1856, cattle were reared here, and there are still said to be several herds in a wild state. In later years a factory was built on its North side, to develope the trade with the neighbouring coast in ground-nuts and palm-kernels, but this and the boat jetty are now in a ruinous state. On a slight eminence stands a villa of moderate size.

Matacong is very unsuitable for commercial purposes, being surrounded by mud-banks and rocks in all directions, so that no vessel of any burden can lie at anchor within 2 miles of it. The channel, which divides it from the main, is nearly three-quarters of a mile wide, but its muddy bottom is left dry at low water.

Between Matacong Island and *Sallatook Point*, 14 miles to S. ½ E., the coast forms a bay, the estuary of the Forikaria and Mellacoree Rivers. The general features of this coast are the same as those already described, but the mountains are too distant to be distinctly seen; here and there a *cotton-tree*, with smooth trunk and spreading foliage, rises above the surrounding thickets, and serves to identify the locality of the coast to those who are acquainted with it; but a stranger can make the mouth of the river which he intends to enter, by his latitude only, or by running along the coast from some known point.

Forikaria River.—From Matacong Island the coast trends E.S.E. for 3½ miles, when it turns abruptly to the northward, and forms the West point of the *River Forikaria* or *Forecarreah*, all this shore being fronted with sand and mud-banks, which extend more than 3 miles to the southward. The entrance of this river is 2 miles wide, and the least depth in it is 6 ft. at low spring ebbs. To sail in, it will be necessary to pass close to the banks which project from the West point, but, at the same time, to be cautious in approaching them, as they are steep-to, and dry at low water. The outer sand will be apparent, even in fine weather, at any time but high water, and, if seen, it may be safely skirted in 2 fathoms near low water, or in 4 fathoms at high water. To avoid getting to the northward of the southern prong of this sand, do not bring the highest part of Matacong Island to the westward of N. by W. ½ W., until the West point of the river bears N.E. You may then safely enter, recollecting as a guide that you should always keep the western side aboard, off which, however, you will have to edge occasionally to avoid the banks.

At about 1 mile within the entrance the river is barred by a ridge of rocks which extends nearly across it; here the ebb tide is extremely rapid, and the overfalls in the vicinity of the rocks are dangerous to those who do not possess a local knowledge of the river. Within the rocks the river deepens to 4 and 6 fathoms, and about 12 miles up is the large village of *Berika*.

The RIVER MELLACOREE, or Mellakori, divided by *Tanna Island* from the Forikaria, has been of considerable importance from its trade in timber, and several factories established on it by the English and French. Its entrance is 1½ mile wide, with depths of 4 to 7 fathoms on its northern side, into which runs the *Tanna River*, also navigable, though much smaller, and the tides are not so strong as in the main stream. The Tanna and Forikaria are connected by creeks. At 7 miles up the Mellacoree, on the South bank, is the mouth of *Sambo River*, which communicates with Scarcies River. About 8 miles above this is *Malaguia*, the residence of the native chief, and at 5 miles farther on the river becomes navigable for canoes only.

The entrance of the Mellacoree has better objects for leading marks than any of those already described, and the facilities of its navigation are greater, yet buoys or a pilot are indispensably requisite. Pilots may be obtained at Sierra Leone. On account of the soft nature of the bottom, vessels may ground in several places in the vicinity of the river, without being injured; but a patch of foul ground, which surrounds the long reef of Sallatook Point, must be carefully avoided.

Sallatook Point, on the South side of the approach to the Mellacoree, is a projecting wooded point, higher than the adjacent coast, with a rocky reef extending 1½ mile N.W. and North of it. Between this and Tanna Island are extensive banks, the Middle Ground dividing the approach into two channels; the southern one is the wider and deeper of the two, and may be used by vessels drawing 15 ft. at three-quarters flood, when the least water found in it will be 19 or 20 ft., hard sandy bottom. *Middle Ground* is a steep bank of hard sand, partly drying at low water, its edge generally being marked by strong ripplings. It is high water, on full and change, at $7^h\ 40^m$; springs rise 11 feet.

Directions.—At 8 miles westward of Sallatook Point the depth is 5½ or 6 fathoms, and, with the river's mouth bearing E. by N., it will be fairly open. To enter by *South Channel*, steer toward it, in that direction, until the soundings decrease gradually to about 3 fathoms at low spring ebbs, with the following bearings:—West point of Yellaboi Island, S. by E.; Sallatook Point, distinguishable by the trees being higher than elsewhere, S.E. ½ S., distant about 3½ miles; Bentee Point, known by a remarkable large tree, about E. by N.; Tanna Point, E. by N. ¾ N.; and the rounding of the land to the northward of the river, N.E. ½ N.; you will then be in the fairway of the entrance. *Middle Ground* is steep and dangerous, but the soundings on the southern side are gradual, though the mud-bank is very wide; borrow, therefore, rather on that side until nearly as far as *Bellangsang Point*, on which were three conspicuous trees, when haul over to the mouth of Tanna River, and there anchor.

If entering by *North Channel*, which is only available for small vessels, when within 5 or 6 miles of the coast, bring Tanna Point to bear E. ¾ S., and by carefully using the lead, you may proceed in with safety; for, although at its eastern end this channel takes a slight turn round the N.E. corner of the Middle Ground, yet this is generally so well indicated that you can scarcely be deceived.

Above Tanna Point the channel becomes much narrowed by rocky banks extending from the South shore, and from the East point of Tanna River. Higher up are some patches of rocks in the middle of the river, but at low water they are seen, as well as the deep-water channel between them, which is one-third of a mile in breadth, with a depth of 7 to 9 fathoms. A *red beacon*, surmounted by a cone, marked either side of this channel. By keeping the East point of Tanna River bearing N.W. by W. ½ W., you may pass through this channel in safety; and, there being no further danger, you may ascend the river to the factories established below *Devil's Island*, on the South shore; the general depth varies from 5 to 9 fathoms. On *Bentee Point*, 2½ miles below Devil's

Island, is a French settlement, and above this the river is navigable for vessels drawing 10 ft. as far as *Tumani*, 4 miles above Devil's Island, and they may even proceed up to Malaguia.

From Sallatook Point the coast trends 7 miles S.S.E., to a small river, on the western point of which is *Sangatook* factory; and about 1¼ mile farther on is the mouth of another small river, the *Inglis Pahboyeah.*

Yellaboi Island, 1¼ mile westward of Sangatook, is surrounded by mud-banks, which dry at low water. It is a low, swampy island, nearly 2 miles in length, N.W. and S.E., and covered with trees, which, toward its western extremity, give it the appearance of an abrupt cliff.

Corteemo or Kortimo Island, 3½ miles S.S.E. of Yellaboi, is 3 miles long, E.S.E. and W.N.W., by 1¼ mile in width, with extensive mud-banks reaching 4 or 5 miles to the westward and north-westward of it, partly dry at low water. It lies 1 mile off the coast, and in mid-channel between is *Yellagumba Islet;* the channel to the Scarcies Rivers passes between Corteemo and this islet, with depths of 3 to 4 fathoms.

The boundary between Senegambia and Sierra Leone is at *Mahala Creek*, situated between the Mellacoree and Great Scarcies Rivers.

SCARCIES RIVERS.—The estuary of these two rivers is fronted by the mass of shallow shifting banks on which lie Yellaboi and Corteemo Islands. The northern or *Great River* is navigable for large vessels, but the *Kaba* or *Little Scarcies* can only be entered by very small vessels. On *Kakonka Islet*, 2 miles E. ¾ S. from Corteemo, is an English settlement, but no supplies could be obtained here, except fish. About 10 miles above Kakonka is a factory at *Mambolo*, which can be reached by vessels drawing 15 feet. Above this the Great Scarcies is only navigable for 8 miles by vessels of less than 10 ft. draught, and boats can proceed 12 miles beyond this, as far as the rapids at *Kambia*.

Yellaboi Sound, the northern approach to the Scarcies Rivers, is the best channel, for, although the banks are steep, yet it is broad and deep, and, by taking a proper time of the tide, large vessels might enter and moor off the South point of Yellaboi Island. The chief difficulty is the shifting bar, between Yellaboi and Corteemo Islands, but a stranger going into the river should procure a pilot at Sierra Leone. It is high water, on full and change, at $7^h\ 10^m$; springs rise 10 feet.

Directions.—To reach the anchorage South of Yellaboi, bring the West end or highest part of this island to bear E.N.E., and steer toward it in that direction, until the depth decreases to 5 or 4 fathoms, which will happen suddenly. Now change the course, and keeping in 4 to 5 fathoms, steer direct for Inglis Pahboyeah River, bearing E. ¼ N., taking care to keep it well open of the South point of Yellaboi, until the West point of that island bears N. by E. ¾ E., when haul directly in toward it, and skirting along the steep mud-bank which borders the South side of the island, steer for its South point, close to which you may anchor in 4½ fathoms. In reaching this anchorage, the least depth passed over will be 2 fathoms at low spring ebbs; and this occurs only after hauling in for the island, and while running along the edge of the mud-bank.

A timber-ship lying at this place, could easily have her cargo rafted down to her, excepting during the *rains*, when, as affirmed, the strong winds occasion so heavy a sea, as to make it unsafe to lie there with her raft-ports open. With little difficulty, however, she might proceed to Kakonka Island; though the channel is narrow and crooked, and would perhaps require buoys to mark it. It would be scarcely possible to give intelligible marks for this winding channel, but it is so apparent in the plan, that by keeping a boat ahead, and never passing over the 3-fathoms boundary line described therein, except in crossing the three short flats North and South of Yellagumba Island, you can scarcely go wrong; the bottom, also, is so soft, and the water so smooth, that no damage will arise from touching.

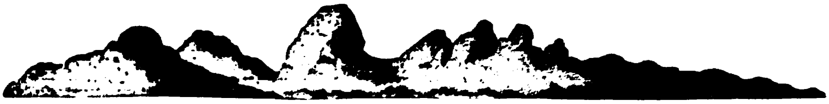
From *Ballo Point*, on the South side of the entrance of the Scarcies, the coast trends 18½ miles S. ½ W. to Tagrin Point, on the North side of Sierra Leone River. It is all low and wooded, fronted by a wide flat, reaching 3 to 10 miles off to the 3-fathoms line. On the southern part of this flat, at 6 miles N.E. by N. ¼ N. from Cape Sierra Leone lighthouse, and 2¾ miles off shore, is *Cooper Rock*, which generally breaks.

SIERRA LEONE is a mountainous peninsula, forming a prominent contrast with the low coast on either side. The mountains may be seen in *clear weather* 40 miles off; but as, on this coast, the weather is generally hazy, it is seldom seen farther off than 20 miles, and frequently not more than 10 or 12 miles; although, at the same time, a good observation may be had. This is occasioned by the constant vapours, caused by the sun, which ascend from the mountains covered with thick woods. The peninsula forms the South side of the entrance of a wide river, the coast northward of which is low and level; but on the South side the land rises into wooded hills, which, forming one above the other, tower into lofty granite mountains, rising 2,000 to 3,000 ft. above the sea, and crowned with perpetual verdure; the highest peak is known as *Regent Mountain* or the *Sugarloaf*. These are, properly, the *Sierra Leone*, or *Lion Mountains*, which have given name to the river and country. From the foot of the hills, points of land, projecting into the sea, form excellent bays for shipping and small craft, and convenient places for hauling the seine.

The English government first formed a settlement here in 1787, the new colony being partly peopled by negroes from America and the West Indies. The present boundaries of the colony are between Mellacoree and Scarcies Rivers on the North, and Manoh River on the South, thus having a coast-line of about 180 miles in extent, and an area of about 4,000 square miles. By the partial census of 1891, the population numbered 74,835, of whom only 224 were Europeans.

CAPE SIERRA LEONE, the N.W. extremity of the peninsula, when first made out, appears like a low point with a line of cocoanut palms close to the water, and on a nearer approach the lighthouse comes into view. There is deep water close up to it, but vessels must not attempt to pass within a mile of its western side, as a detached rock, called the *Carpenter*, lies 7 cables W.N.W. from the N.W. extremity of the cape. This rock always shows itself by the breakers over it, and at half-tide may be distinctly seen. You may advance within half a mile of the rock; but those beating down the river with the sea breeze, and a strong ebb tide, must be careful and give it a good berth, as the ebb tide sets strongly to the S.E. between the rock and the cape, the flood stream sets northward directly through this channel.

From the cape, a ledge of rocks extends toward the Carpenter, and the tide-rip in this channel is dangerous for boats. *Bromham Rock*, with 2½ fathoms over it at low water, appears to be the outer part of this ledge of rocks. It lies 3 cables S.W. by W. ½ W. from the lighthouse, and 5½ cables S.E. by E. ½ E. from Carpenter Rock, the channel between being deep and clear, but it should only be attempted in case of necessity.



Appearance of Cape Sierra Leone, bearing S.E. by E., distant about 15 miles.

The Lighthouse on the extremity of Cape Sierra Leone stands in lat. 8° 30′ 10″ N., long. 13° 18′ 5″ W., and was completed in 1849. It is a white tower, 69 ft. high, showing a *fixed* and *flashing bright* light, with a *flash* every half-minute, elevated 75 ft. above high water, and visible 14 miles.* At 23 ft. below this a *fixed red* light, visible 10 miles, is shown over Carpenter Rock, between W. ½ S. and W. by N. ¾ N.

From the lighthouse Carpenter Rock bears W. ½ N., distant 9 cables, and the western edge (3 fathoms) of Middle Ground N.E. ½ N., nearly 2 miles.

Sierra Leone River entrance is 1¼ mile in width, with depths of 5 to 10, 12, and 15 fathoms, between the northern coast of the peninsula and the southern side of the *Middle Ground*, which is reported to be extending. This is a bank of hard sand, with patches of large stones, extending from the Bullom shore, on the North side of the river, dry in several places at about half-ebb, and at all times the sea breaks over it. Its outer extremity, in 4 fathoms, lies 1¼ mile N. ½ E. from the lighthouse. The passage northward and eastward of the Middle Ground is only fit for small vessels, the depth over the bar on the eastern part of the bank being only 9 to 12 ft. at low water.

Sierra Leone River is navigable for boats as far as *Rokel*, about 40 miles above Freetown, between which place and *Rokon* there are rapids, and navigation is dangerous. Steamers do not ascend beyond *Benkia*, about 15 miles above Freetown.

The *Bullom Shore*, which forms the North side of the entrance of the river, is level and covered with wood. Off this shore, in lat. 8° 37′ N., is *Leopard Islet* and rocks, whence the coast rounds to the south-eastward, 7 miles, to *Tagrin Point*, and between are several negro towns, of which the fourth, from the northward, is that of the King of Bullom. The edge of this coast is low, swampy, and bordered with shoals. In the river, eastward of Tagrin Point, are *Tasso Island* and several smaller isles, the formation of which can be understood only by reference to the chart. Just above Tasso is *Bance* or *Bence Islet*, occupied by the ruins of the old battery and factory of the Royal African Company.

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* This light is reported to be irregular, so due caution is necessary.

Within Cape Sierra Leone the general trend of the coast is E.S.E., for 5 miles, but it is broken by several inlets, which are called *bays*, where excellent fish may be caught with the seine, and sometimes green turtle. Of these, the first within the cape is a small cove, of pleasant appearance, called *Cape Bay;* the next is *Pirate Bay*, so named from being the place where the pirates formerly used to careen and refit their vessels; the third is *English* or *Whiteman Bay;* the fourth, *St. George*, *Kru*, or *Freetown Bay*, whereon stands Freetown. To the East of Freetown is *Susan Bay*, and at a mile eastward of the last is *Thompson Bay*, bounded on the East by *Farran Point*.

Lookout Point is the projection dividing Pirate and English Bays, and on the high land, about three-quarters of a mile within it, is a look-out station. *King Tom Point* is the northern extremity of a flat wooded peninsula, dividing English and St. George Bays; on it is a battery, and on its eastern side is a large mission establishment. A *red buoy*, marking the telegraph cable, lies 1 cable E.N.E. of the point, but it is liable to drift.

FREETOWN, the capital of Sierra Leone, is picturesquely situated on the slopes of the hill on which stands *Fort Thornton*, and above the fort, on an elevated plateau about 400 ft. high, are the hospital and barracks.* The general aspect of the country in the immediate vicinity of this colony, and the external appearance of Freetown, give a stranger, on arrival, an idea of salubrity and prosperity, which subsequent experience may not altogether realize.

Its more striking features are the largeness of the scale on which the public buildings are constructed; the wideness of the streets, and the regularity of their lines; the number of stone houses, and the excellence of the roads; the abundance in the markets, the multitude of well-dressed negroes in these places, the variety of stalls and shops in their own quarter, well supplied with English goods; the cleanliness and the comfort of their small abodes, the size and structure of the principal church, and the numerous chapels and schools in the town and suburbs; and last, though not least, the admirable order that seemed to prevail amongst the negro population, without any apparent exercise of magisterial severity, or rigour of political restraint, to repress or control the people.

The Climate of Freetown is oppressively hot, damp, and muggy; the annual mean is 79½° F. The wet season begins in May, and ends in November, and an average of eight years (1878—1885) gives the annual rainfall 147 inches. The rains end in the sickliest season of the year, when ague, fever, dysentery, &c., are prevalent. The dry season lasts from November to April.†

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* In October, 1892, the captain of the German cruiser *Habicht*, stated that Fort Thornton can no longer be used as a mark for sailing in or anchoring, being completely hidden by trees and buildings. He recommends the battery at the S.W. end of the barracks as a good mark, which can be used on much the same bearings as Fort Thornton.—*Annalen der Hydrographie*, 1892, page 424.

† "To the Gold Coast for Gold," by Captain R. F. Burton, and Commander V. L. Cameron, 1883.

From ten o'clock in the morning till five in the evening a white man is seldom seen abroad; at the latter hour, the race-course and the promenade on the battery are frequented by equestrians and pedestrians; and, perhaps, no circumstance that strikes the attention of a stranger makes so strong an impression on his mind, as the general expression he observes of languor and debility in the looks of every individual he meets of European birth (with perhaps two or three exceptions) in the colony. The young and old, the acclimated even as they are deemed, who have had their seasoning, either in one fever, or the periodical return of that malady, and have survived these attacks, show plainly enough the baneful influence of the climate, which leaves the features without vivacity, the frame without vigour, and the whole constitution apparently deficient in vitality.

In 1891, the population of Freetown numbered 30,033. Trade consists chiefly in the export of palm kernels and oil, india-rubber, kola-nuts, copal, gum, and hides, estimated to have a total value of £441,425, in 1891; the imports were valued at £453,378. In that year, 899 vessels entered the port, with a total tonnage of 425,853. Steamers call here regularly, and there is telegraphic communication with Bathurst, Isles de Los, Accra, &c., and Europe. Supplies of provisions and good water can be obtained here; coal is stored in large quantities, and can be put on board from lighters at the rate of about 300 tons a day. At present there are no facilities for repairs, but surveys for proposed docks were made in 1891. Tonnage dues were abolished in 1888.

Light.—A small *fixed green* light is shown on the eastern end of Government Wharf.

Tides.—It is high water at Freetown, on full and change, at 7ʰ 50ᵐ; springs rise 12½ feet.

During the rainy season the tide is very regular and strong, sometimes running 6 and 7 knots an hour, and the ebb sets rapidly on the Middle Ground. In the dry months it commonly flows on shore at 7ʰ 30ᵐ, with 7½ hours ebb, and 4½ hours flood; in this season the ebb runs 2½ miles an hour, the flood only 2 miles.

Directions.—In standing in for soundings, approaching Sierra Leone, keep the lead constantly going, as the current sets in various directions, but generally tending to the eastward. It is requisite to be very attentive to this particular. In 1881, H.M.S. *Orontes*, and later on in the same year the steamer *Benguela*, struck soundings in 9 to 10 fathoms, fine white sand, about 40 miles W. by S. ½ S. from Cape Sierra Leone, on a bank apparently extending 10 miles N.N.E. and S.S.W. The depths around vary from 12 to 15 fathoms.

Vessels bound from Cape Verde to Sierra Leone are recommended to gain soundings in lat. 9° 15′ N. on the great bank which extends from the Bissagos to Cape St. Anne; and having gained bottom in 50 fathoms, gray sand, on the edge of the bank, to make a S.E. by S. course, keeping in soundings until in lat. 8° 20′ or 8° 30′. When in lat. 8° 30′, a *true* East course along this parallel leads direct to Cape Sierra Leone, and the depth of 10 fathoms will be found about 13 miles off it, and at night the light should be visible. In proceeding hence toward the river, the soundings decrease to 9, 8, and 7 fathoms, at 9 miles off, and at night a stranger may then anchor and wait for daylight, and so avoid being drifted away by tide and current.

Vessels from the northward, when bound to Sierra Leone, should be careful how they approach the cape. They must keep their lead going, and not approach the coast any nearer than in 6 fathoms, until they see the high land, which should be steered for on an E.S.E. bearing. In clear weather the cape may be made out when 10 to 15 miles distant, and by steering for it on a S.E. by S. bearing, the vessel will pass well to westward of the Middle Ground, and, with a commanding breeze, a sailing vessel may approach the cape to a distance of a quarter of a mile, but allowance must be made for the tidal stream. Pilotage is not compulsory.

By night, when approaching from the northward, the light on Cape Sierra Leone should not be brought to bear southward of S. by E., which will lead clear of the bank and Middle Ground. If from the westward and southward, do not bring the light to bear eastward of E. by S. ½ S., to avoid Carpenter Rock. On rounding the cape, the *green* light at Freetown will act as a guide for the anchorage.

From abreast the cape a S.E. by E. ½ E. course, for 3½ miles, will lead to the anchorage off Freetown, the depths passed over from 20 to 10 and 9 fathoms; by keeping near the shore the tides will be found less strong, and Middle Ground and the eddies near it will be avoided. Farran Point bearing S.E. by E. ½ E. will lead in mid-channel up to the anchorage. King Tom Point, bearing S.E. by S. ½ S., in line with the centre barrack, leads close to 3 fathoms on the western edge of the Middle Ground. In working into or out of the river, which should only be attempted with a favourable tide, advance no nearer towards the Middle Ground than in 7 fathoms.

To anchor a large vessel off Freetown, bring the barracks battery to bear S. by W.; the light on Government Wharf, S. by W. ½ W.; and King Tom's Point, W. by N. to W. ½ N.; this will be 1½ to 2 cables off shore, in 16 to 18 fathoms, mud. Moor with the best bower to the eastward. The watering place here is very convenient and the water excellent; you may fill your casks in the boat, with a hose which leads from a cascade, at the western end of the town.

In sailing up beyond Freetown to Farran Point, or farther eastward, you will find deep water, but the soundings rather irregular. You may make free with the shore all the way up, as it is very bold, but if proceeding far up the river vessels must take a pilot.

Farran Point is remarkable, being elevated, with a house on its summit. In hazy weather, several vessels, on coming in, have mistaken this point for Cape Sierra Leone, although it is 4½ miles E.S.E. of the cape, and have thus touched on the Middle Ground.

The Coast.—From Cape Sierra Leone the coast, at the foot of the mountains, forms a slender sandy bay, bordered with trees, which extends more than 3 miles to the southward of the cape, where it terminates in a rocky point. At three-quarters of a mile farther on is another point, which is more conspicuous and projecting, named *False Cape,* 4½ miles S. by W. ½ W. from Cape Sierra Leone. From False Cape to the village of *York,* on the North side of the stream called *Sisters River,* the coast trends irregularly S. by E. ¼ E., 11 miles; and from Sisters River to Cape Shilling, S. by W. ¼ W., 6½ miles. All this coast is safe to approach, depths of 4 to 6 fathoms being found at 1 mile off shore, but several detached rocks lie off the southern half of it.

Cape Shilling, or *Chilling*, is low, and covered with trees, and at a distance of 12 or 15 miles it appears like a small island. Here the hills of Sierra Leone terminate, after forming a high double range, which may be seen a long way off. The peninsula attains its greatest elevation in its southern part, and when not enveloped in clouds the summit may be seen at the distance of 40 or 45 miles. On the North side of Cape Shilling is *Kent Town*, formerly a village of liberated Africans and disbanded negro soldiers, delightfully situated on the side of a hill, with a large house for the superintendent.

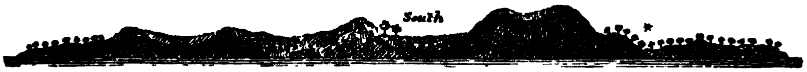
Shallow water extends 1¼ mile S.W. of Cape Shilling, and at half a mile S.W. ¾ S. from the cape is a small rock above water named *Thistle Rock*. Nearly 1¼ mile S.W. ¾ W. from the latter is *Wolf Rock*, also above water, with 7 fathoms close to it.

BANANA ISLANDS lie 2⅓ miles S.W. by W. ½ W. from Cape Shilling, irregular depths of 3½ to 9 fathoms being found in the channel between. They are narrow and of irregular outline, together extending 4¾ miles E.N.E. and W.S.W., and the greater part of their coast is rocky and foul, with off-lying rocks in some parts, so large vessels should not approach them closely. There were formerly three islands, but the narrow strait between the middle and N.E. islands has been filled up by the natives. *Banana Peak*, the summit of the islands, attains an elevation of 900 ft. near the southern end of the larger island, and is well wooded. The S.W. island, only separated by a very narrow strait, is about 70 ft. high, and there is said to be a copious spring of fresh water at its S.E. point. At nearly half a mile West of its western point is a rock which uncovers at half-tide, with foul ground between. It is high water, on full and change, at $8^h 15^m$; springs rise 9 feet.

The Bananas very much resemble the Isles de Los, but the land is more elevated. They are extremely fertile, and have plenty of water, but no running streams. Wild cattle were abundant upon the greater isle, and it is a remarkable fact, that pigs are the only domestic animals which cannot be propagated here, as there appears to be some herb, of which they are immoderately fond, but which is fatal to their existence. The European residents of Sierra Leone frequently resort to these islands for the benefit of their health.

Mr. Woodville has said, "It is very evident that the whole chain of mountains called Sierra Leone, as well as the Banana Isles and the Isles de Los, are of volcanic origin, if we are to judge from the great quantity of lava found there, and from the small pieces of it taken up by the lead, in sounding, at certain distances from the land, opposite to these islands, and nowhere else; also from the conical figure of many of the hills, and from the ferruginous soil in the country."

Vessels can anchor anywhere, as convenient, between Cape Sierra Leone and the Bananas, and also to the southward of the islands. H.M.S. *Tartar* anchored off Cape Shilling, with the N.E. point of the islands S.E. by S. ½ S., distant 4 miles, and the western part S.S.W. Between the ship and the islands the water deepened to 8, 9, and 7 fathoms.



N.E. Point, S.E. by S. ½ S. * *West Point, S.S.W.*

The Bananas appeared as above, from the *Tartar's* anchorage, at the distance of 4 miles.

In the tornado season, when anchoring nearer the islands, in about 6 fathoms, with the extremes bearing S.S.E. and S.W. by W., if the cable parted, the vessel would drift clear of danger.

There are sandy bays northward of Cape Shilling, which may be seen from the anchorage, and where you may land; but the best is at the S.W. end. Wood and water are obtainable here; the watering-place, which is close to the beach, has a very good run of water.

Tides—The tides divide off the False Cape of Sierra Leone. To the northward of that point the flood runs to the northward, and to the southward it sets to the South. Hence, at the Bananas, the flood is from the N.W., and the ebb the contrary. Here it is high water, on full and change, at $8^h\ 15^m$; during the equinoxes it rises 9 or 10 ft., and at other spring tides 8 or 9 feet. At the Plaintain Isles it rises about 18 inches more than at the Bananas; but at the Bashaw or Turtle Isles, more to the southward, the rise is 6 or 7 ft., at common spring tides.

Yawri Bay.—At 18½ miles S. by E. ¾ E. from Cape Shilling is *Tasso Point.* The coast between forms Yawry Bay, the shore of which is bordered with a shoal 4 miles broad, having on it many oyster-beds. Great part of the bank is uncovered at low water, and has only 4 ft. over it at high water. Depths of 4 to 6 fathoms are found in the centre of the bay, but it has not been closely examined. The *Ribbi* or *Oribi*, *Kamaranka* and *Bompeh*, and *Kaghboro* or *Cockboro Rivers*, discharge themselves into this bay. The northern of these, the Ribbi, is navigable for boats drawing 4 ft. as far as *Mafengbe*, about 22 miles from the entrance. The entrance is much obstructed by sand-banks, but the trade is principally carried on by small schooners, which can cross the bar at almost any time of tide.

Tasso Point is moderately high, with a native village on its southern side. A shallow bank extends 6½ miles W.N.W. of it, on which lie several groups of rocks. *Plaintain Islet*, low and wooded, lies 1¼ mile westward of Tasso Point, with which it is connected by a chain of rocks. Rocks above and below water also extend for 1 mile westward of it. At 2 miles W. by N. ½ N. from Plaintain Islet is the eastern end of a line of rocks known as *Bengal Rocks*, which thence extend for nearly 1 mile W. by N. ¾ N. to a black rock above water. At 1¾ mile N.W. of this rock is a dangerous patch of 6 ft. water, on the edge of the bank.

From Tasso Point the low and sandy coast, forming the North side of Sherbro Inlet or River, trends 12 miles S.E. by S. ½ S. to the mouth of *Yaltucka River*, and thence it winds to the south-eastward, 15 miles farther, to the *Bagroo River*, and is thickly wooded. It is bordered by a mud-bank, off which are several shoals, the positions of which can be understood only by reference to the chart. *Buoy Point*, midway between the Yaltucka and Bagroo, is low, but clearly defined, and at 4½ miles N.N.W. of it was a conspicuous round tree, known as *Mendo Tree*, visible 7 or 8 miles.

Sherbro Island, forming the southern side of Sherbro River, is a low marshy tract, very unhealthy, about 28 miles in extent E.S.E. and W.N.W., and 10 miles across where widest. On its North coast are several native villages, but it is all fronted by extensive shoals. The S.W. coast is thickly wooded, and appears safe to approach, depths of 4 to 5 fathoms being found near the shore, over a bottom of fine sand.

Turtle or Bashaw Islands.—*Cape St. Anne*, the N.W. point of Sherbro Island, is a low sandy point, in lat. 7° 34′ N., long. 12° 57′ 45″ W. Extending to the North and N.W. of it is the great flat known as *Turtle* and *Sherbro Bank*, on which is a group of eight or nine wooded islands, called the *Turtle* or *Bashaw Isles*, which appear to be the remains of a considerable tract of land now submerged by the sea. The bank on which they exist also exhibits innumerable ridges, knolls, blind channels, and pools; but is navigable on almost every part by large boats at high water, and at low water by light boats and canoes. They are inhabited by negroes, who subsist chiefly on fowls, fish, and bananas. *North Island* lies 8¼ miles N.N.W. of Cape St. Anne, and the trees on it attain an elevation of about 75 ft. above the sea. On some of the other islands the trees attain nearly twice this elevation.

SHOALS of ST. ANNE.—These dangerous shoals, which have not yet been thoroughly surveyed or defined, extend over a space of 45 miles N.W. ½ N. from Cape St. Anne. Beyond Turtle Bank they consist of numerous detached patches of fine brown sand, with 3 to 18 ft. water over them, separated by channels of 6, 7, 8, and 10 fathoms. The bank itself is divided from that of the Turtle Isles by a narrow swashway, having 5, 7, and 10 fathoms. They can only be understood by a reference to the chart, and should have a wide berth. The tidal streams set across them, at the rate of 1 to 1½ mile an hour in the dry season, but the ebb probably runs faster in the wet season. In case of need, vessels can anchor between the shoals in depths of 7 to 10 and 12 fathoms, sand and shells, where abundance of fish may be caught, but the sea is generally rough during the wet season.

The outermost, or *North-West Patches*, with 15 ft. least depth at low water springs, lie 21½ miles West of Banana Island peak, in lat. 7° 58′ N., long. 13° 34′ W. Another small 15-ft. patch lies 5 miles nearer the peak. Outside these the depth increases to 7, 10, and 15 fathoms, but there are some detached patches of 9 and 10 fathoms, of which *Orontes Bank*, described on page 694, appears to be the outermost.

Too much care cannot be exercised in approaching these dangerous shoals, as less water may be met with than is shown on the chart, and the coast is too distant to provide leading marks. But it appears that a vessel bound from Sierra Leone to the Windward Coast will clear every danger by proceeding over the great bank S.W. by W., for 37 miles from the cape, to the parallel of 8° N.; and thence, S.S.W., on the meridian of 13° 40′, to lat. 7° 30′, from which point a course S.E. by E. ½ E., 65 miles, leads to the Shebar entrance of Sherbro River, at the S.E. extremity of Sherbro Island.

Captain Midgley recommends that, "in the wet season, vessels should give the St. Anne Shoals a large berth to the eastward, as the current, as well as the sea, runs with great velocity into the bight of Cape Mount, and vessels which may unfortunately happen to fall in with the land to the northward of Sinou, in the wet season, will find considerable difficulty in working to the southward."

SHERBRO RIVER, the inlet or sound between the Shoals of St. Anne and Sherbro Island on the S.W., and the main land on the N.E., is formed by the estuary of the Rivers Bagroo, Jong, and Boom-Kittam, and its shores may be described as one vast mangrove swamp. It is 21 miles in width between Plaintain Island and Cape St. Anne, but the navigable channel is contracted to a width of 4 miles between the shoals on either side. Above Yaltukka River the channel decreases rapidly in width, and is encumbered with numerous detached shoals. The depths in the navigable channel vary from 5 to 10 and 14 fathoms in the outer part, but they decrease farther in, and vessels drawing 15 ft. can reach the settlement of Victoria, on the S.E. side of Sherbro Island. The aid of a pilot is necessary for the river navigation, and no vessel drawing more than 18 feet can safely ascend it. The tidal streams run about 2 miles an hour.

The North shore of Sherbro Island is 23 miles in extent, from Cape St. Anne on the West, to *Jamaica Point* on the East. At 12½ miles eastward from Cape St. Anne, is the spot and remarkable tree called *Little Pow Grande*, and 3 miles farther on is *Pow Grande*. At 4½ miles eastward of Pow Grande is *Jenkins Village*, off which the depth is from 5 to 6 and 7 fathoms. All the shore between this and Cape St. Anne is bordered with an extensive mud-bank.

Between Buoy Point (page 698) and Jenkins, a great part of the channel is occupied by the *Middle Ground*, parts of which dry at low water. *Bagroo Channel*, northward of this shoal, has depths of 4½ to 6 fathoms soft mud bottom, and may be considered as the general roadstead for large vessels. *Jenkins Channel*, South of the Middle Ground, has deeper water, but the approach is intricate, and the bottom of hard sand.

Bagroo River is 1½ mile wide at its entrance, with depths of 3 to 4 fathoms. Just within is *Edmonstone Island*, lying on a bank extending from the eastern shore. At 5 miles from the entrance is *Raleigh River*, and above this the Bagroo becomes very narrow and winding, but is navigable for steam-launches as far as *Tasso*, 15 miles from the Sherbro.

Buoyage.—In 1870, the channel of the Sherbro was buoyed as follows, but in 1880 the buoys had all disappeared, and at the present time they cannot be depended upon.

A *white* fairway buoy was moored in 4½ fathoms, 4½ miles W. ¾ N. from Plaintain Island, and at 8¼ miles S. ¾ E. from this was *Carpenter* buoy, in 8 fathoms, 2 miles East of the northern prong of Turtle Bank. A *black* and *white* buoy lay in 9 fathoms, 9 miles S.E. by E. from Carpenter buoy, and 3 cables off Yaltukka River shoals.

Directions.—The buoys being unreliable, a pilot is necessary for the safe navigation of the Sherbro, but if one be not available, a vessel may proceed as follows, using every precaution. When the peak of Banana Island bears East, distant 5 miles, a S.E. by S. ½ S. course, for 21 miles, will lead in depths decreasing from 17 to 14, 10, 8, and 6 fathoms, to a position 5½ miles S.W. of Plaintain Island, passing 3 miles westward of Bengal Rocks. Then alter course to S.E. ¾ S., and proceed by the chart, and by keeping clear of the shoals a least depth of 4 fathoms at low water will be found up to Bagroo River entrance, passing southward of a 10-ft. patch lying 8 cables southward of Buoy Point.

From the Bagroo the channel passes midway between Sherbro Island and *Bobs Island*, until within 1 mile of *Jamaica Point*, when the channel becomes narrow, and passes along the S.W. side of Bobs Island, with a depth of 19 ft. at low water. A course about S.E. ½ E., will lead to *Long Island*, off the South end of which the channel is barred by a flat, with 15 ft. over it at low water. Here the houses on *York Island* become visible, and off them there is anchorage in 24 ft., mud.

Jong River runs into the wide estuary eastward of York Island. A least depth of 9 ft. is found in the entrance at low water, and the upper parts of the river are well populated.

Bonthe', the residence of the Government officials, is on the East coast of Sherbro Island, westward of York Island, and about 2½ miles southward of Bonthé is *Victoria*, another English settlement. On the coast, opposite Victoria, is the village of *Bendu*, and vessels drawing 15 ft. may proceed as far as this, by buoying the channel, but the tides are strong. This place is of no great commercial importance, trade consisting chiefly in the export of rice and fruit to Sierra Leone, in exchange for the usual articles of commerce.

Shebar Entrance to Sherbro River is nearly 1 mile in width between the S.E. extremity of Sherbro Island and Manna Point, but it is fronted by a bar between long sand-spits on either side, probably shifting, over which the sea is always breaking. The bar lies 3 miles West of Manna Point, and is said to have 18 ft. over it at high water, but it is not safe for vessels drawing over 10 ft., and the aid of a pilot is necessary. Inside the bar the water deepens considerably, and there is little difficulty in the navigation up to Victoria, 7 miles to the N.N.E. of Manna Point. Vessels can anchor in 9 or 10 fathoms, about 1 mile off the bar.

Boom-Kittam River has its wide estuary northward of Manna Point, and runs parallel with the shore for many miles to the south-eastward, the land between being known as *Turner Peninsula*. Though of considerable magnitude, and extending far into the interior, it is only navigable by vessels drawing 4 or 5 ft., during the dry season. In the rainy season the level rises 12ft. in its lower part.

Tides.—Off Plaintain Island it is high water, on full and change, at 6^h; springs rise 11 feet. Near Victoria, at 8^h 15^m, and here springs rise only 4 feet. In the Shebar Entrance the tides run at least 4 knots an hour, in the dry season, and meet the Sherbro tides off Bobs Island.

The Coast.—From Manna Point the coast runs nearly in a straight line S.E. ½ E., for 58 miles, to the entrance of Gallinas River. It is all low and sandy, backed by trees, and appears to be steep-to and free from off-lying dangers. In 1888, H.M.S. *Racer* struck soundings in 11 fathoms, 17½ miles West of Gallinas River entrance, the depth around being 35 fathoms. In about long. 11° 58′ W. is a white factory on *Kittam Point.*

Off the entrances of Gallinas and Sulima Rivers, the coast is fronted by a narrow sandy barrier, about 7 miles in length, and between lie several low wooded islands. The water escapes by one or two shifting openings in this barrier. The coast here is very low and remarkably uniform, and trees, higher than those around, form the only landmarks.

Gallina River entrance is consequently difficult to recognise from the offing, but the depth decreases regularly towards it, and trading vessels anchor in 7 fathoms, about 1 mile westward of *Kamasun Island.* The bar is only passable for large native boats or small coasting craft, and is very dangerous during the rains, when it is frequently impassable. During the dry season it may be generally passed with safety, except occasionally at the full and change of the moon, which has a very marked effect upon the surf on the whole of this coast. It is high water, on full and change, at $6^h 45^m$; springs rise only 4 feet.

After passing the bar, the river opens out into a spacious lagoon, which is studded with islands formerly occupied by the slave dealers, and affording very favourable situations for trading factories. In the rainy season, the North end of this lagoon is connected with the Boom-Kittam River, thus affording inland water communication by boat with Sierra Leone. At 9 miles up the Gallinas is the town of *Ghindamar,* the residence of the chief, and the river is navigable for 15 miles by large canoes.

Sulima River runs into the lagoon at 2½ miles S.E. of the Gallina, and has a conspicuous wooded islet in its mouth. On the South side of the entrance, on the sea-coast, is the native village of *Sulima,* where landing is difficult on account of the surf. Large canoes can ascend the river for 7 miles above the village.

From the River Sulima to Cape Mount the coast is very low, and covered with trees, and has a fine sandy beach all the way. At 3 or 4 miles off there are regular soundings, from 14 to 17 fathoms, mud and sand.

Manna or Manoh River entrance, 5½ miles S.E. of Sulima, is only accessible for surf-boats, being nearly closed by spits of sand, on which there is always a great surf. There is anchorage off it in 8 or 9 fathoms. This river forms the boundary between Liberia and the English territory, the left bank being included in the English side.

LIBERIA is a negro republic, founded in 1823, occupying the coast between Manna River and San Pedro River, in long. 6° 40′ W., its coast-line measuring about 500 miles, and its area is 14,360 square miles. The population numbered about 1,000,000 in 1891, and the capital is Monrovia. The commercial products consist chiefly of palm-oil and kernels, coffee, dye-woods, ivory, and sugar.*

The Climate of Liberia is usually divided into the wet and dry seasons, but their limits are not strictly divided; the former usually begins in the middle of May and lasts till the middle of November, June being the wettest month. In November and December the weather is pleasant. January is the driest month, and March the most trying to Europeans. The Harmattan is experienced from the middle of December to the end of February, and tornados occur in April.

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* For an interesting account of Liberia, the reader is referred to an article given in the "Journal of the Manchester Geographical Society," 1888, pages 233—248, by Mr. E. B. Gudgeon, Consul in London.

Manna Point, 4½ miles S.E. ¾ S. from Manna River entrance, is low and rocky, but inland to the N.E. is some high land visible from seaward for a considerable distance. It is sometimes called *Roc-Manna*, from the unusual circumstance of the shore being covered with blocks of black rocks, which extend one-third of a mile off shore.

At 2 miles S.E. of Manna Point, the coast again becomes fronted by a narrow sandy barrier, extending 5½ miles in a southerly direction. The narrow lagoon within this barrier is known as *Sugari River*, on the shores of which are several villages or factories, but its depth is only about 6 feet.

CAPE MOUNT, which may be seen at 25 or 30 miles off, is a hilly promontory, projecting into the sea, the southern and highest peak rising 1,066 ft. above the sea; on each side the land is low, rather highest on the North side, with a flat sandy beach to the north-eastward. The cape itself is distinguished by cliffs, which may be seen 12 miles off. It is very remarkable, especially in coming from the westward, when it first makes like an island, and contrasts greatly with the low and uniform coast to the N.W. of it.

From the northern end of Cape Mount extends a long narrow tongue of land, its northern extremity passing to the westward of the South end of the barrier forming Sugari River, the entrance of Cape Mount River lying between.

In the bight of the coast North of the cape there are depths of 6 to 8 fathoms, bottom of sand or black mud. H.M.S. *Tartar* anchored in 15 fathoms, muddy bottom, Cape Mount bearing S. by E., and a remarkable large clump of trees North. Merchantmen anchor farther in, in 9 and 10 fathoms. Here also, in the summer season, that is, between the months of October and May, when the weather is generally fair, there is anchorage in depths of 9, 8, 7, and 6 fathoms, sandy ground; but from 15 to 12 fathoms should be preferred in the rainy season, and even there it is hazardous, unless provided with the best ground tackle; for southerly and S.W. winds, in that season, set into the bight with a tremendous sea and heavy gusts, raising a violent surf on the shore, which may be heard at a great distance.

The watering place is near a large tree in front of the outer point of the cape; and here, in the fine season, you may take in water with great facility. In coming ashore with the boat, you must bring a hawser with you, and fasten one end of it to the land, the other being dropped with the anchor to seaward, so that you may prevent the breakers by it; for you run directly against the flat beach below the town, without any shelter of banks or cliffs. In the morning you may easily get ashore with smooth water.

To fall in with Cape Mount, when approaching from the westward, you ought to keep in the latitude of 6° 40′ or 6° 45′, having, on account of the current which sets towards the shore, frequent recourse to the lead when you think yourself near the land. In the night do not approach nearer than to 20 or 25 fathoms, unless well acquainted, as there is 15 fathoms close inshore. The same precaution should be taken during the *Harmattan,* when the sun is obscured by haze for days together, and the current varies.

Cape Mount River has a depth of 7 ft. on the bar at low water, when the surf breaks heavily, and spring tides rise about 3½ feet. The current runs very strongly out, and the best time for crossing the bar is at half-flood. At 2 miles within the bar, on the North side of Cape Mount promontory, is the settlement named *Robert Port,* and here the channel turns to the S.E. into the extensive lagoon called *Fisherman Lake.*

Marfa River unites with Sugari River just within the bar. An island lies in the mouth of the Marfa, and the channel has only 3 ft. water in places as far as *Kroo Town,* 1 mile up it. Between this and *Makwimba,* about 9 miles farther up, the depth in the river is about 12 feet.

For 3 miles S. by E. ½ E. from Cape Mount the coast at the foot of the mount consists of rocky points separating snall sandy bays, and then turns to the S.E., sinking into a low continuous sandy beach, safe to approach. All this part of the country is thickly wooded. At 25 miles from Cape Mount is *Half Cape Mount River,* which is closed by a sandy barrier in the dry season; vessels can anchor 1 to 2 miles off the intervening coast, in depths of 11 to 13 fathoms. For 10 miles S.E. ½ S. from this stream, the 5-fathoms line is met with about half a mile off shore, and from thence to Cape Mesurado, 9 miles South, the coast is fronted by rocks and shoals, and 5 fathoms is found about 1 mile off. At *Po River,* a stream 8 miles S.E. of Half Cape Mount River, there are many black rocks on the beach.

St. Paul River, 4 miles northward of Cape Mesurado, can only be entered by boats, the depth on the bar being 4½ to 7 ft. at low water, but within the bar it deepens to 9 and 18 ft., and more in places. The banks are well inhabited, and there are several prosperous negro villages and plantations. At 2 miles up, on the South bank, is the large settlement named *Caldwell,* which is connected with Monrovia by *Stockton Creek,* navigable by boats. Vessels can anchor off St. Paul River in depths of 6 to 16 fathoms, mud and sand, from 1½ to 3 or 4 miles off shore.

CAPE MESURADO, 42½ miles S.E. by S. from Cape Mount, is an elevated promontory, rising on its northern side almost perpendicularly to a height of 240 ft., but sloping gently towards the sea on the S.W. It is well wooded and steep-to, and on its N.E. side is a spring of fresh water. When first made out, bearing N.E., it appears like an island, with trees appearing to be rising out of the water to the North, the land on each side being very low.

The Lighthouse, on the summit of Cape Mesurado, is a red tower 40 ft. high, in lat. 6° 19′ 10″ N., long. 10° 49′ 25″ W. It shows a *fixed bright* light, which, being elevated 240 ft., should be visible 15 miles off, but being an indifferent light it is said to be only visible 6 miles, and is frequently not exhibited at all.

MONROVIA, the capital of Liberia, is built on the South side of the entrance of Mesurado River, at the foot of the high land, eastward of the cape; from its fine situation it is more salubrious, and far preferable to Sierra Leone, and in 1891 it contained about 5,000 inhabitants. The exports consist chiefly of coffee, palm oil and kernels, cocoa, sugar, arrow-root, &c., grown in the surrounding settlements; also ivory and hides. The money, weights, and measures in general use are chiefly English.

Supplies of beef and vegetables may occasionally be obtained here, also wood and water, but coal cannot be depended on, though there is a store here. Water was obtained from the river, but in the dry season boats sometimes have to go nearly 7 miles up for it.

Mesurado River can only be entered by boats, the depth on the bar varying from 3 to 9 feet at low water. The entrance is constantly shifting, sometimes being at the foot of the cape, and at other times half a mile to the northward. It is high water, on full and change, at 6^h; springs rise 6 feet.

Monrovia Bay is formed by the bight in the coast between Cape Mesurado and St. Paul River, in which the depth decreases gradually towards the shore. Large vessels usually anchor in 7 fathoms, sand, about 1 mile N. ½ W. of the lighthouse, with the centre of the town bearing S.S.E. A common anchorage is in 10 to 14 fathoms, about 2 miles N.N.W. to N.W. of the cape.

THE DESCRIPTION OF THE COAST south-eastward of Monrovia, with directions for the same, is given in *Findlay's Sailing Directory for the South Atlantic Ocean.*

THE ISLANDS

OF THE NORTH ATLANTIC OCEAN.

3.—THE AZORES, OR WESTERN ISLANDS.

The AZORES, Açores, or Western Islands, belonging to Portugal, are nine in number, arranged in three groups: St. Michael's and Santa Maria on the S.E.; Terceira, Graciosa, San Jorge, Fayal, and Pico, the central group; and Flores and Corvo to the N.W. Santa Maria is about 800 miles westward of the coast of Portugal, nearly on the parallel of Cape St. Vincent, and 460 miles N.W. ¾ N. from Madeira; Corvo is about 1,063 miles S.E. ½ S. from Cape Race, Newfoundland. The group thus occupies an extent of 330 miles N.W. by N. and S.E. by S., between the parallels of 36° 55′ and 39° 44′ N., and the meridians of 24° 45′ and 31° 17′ W. Though lying over so large a space, their united area only amounts to 1,005 square miles, with a population of 269,401 in 1881.* Angra, in Terceira, is the nominal capital of the group; but Ponta Delgada, St. Michael's, is the largest town and the chief seat of commerce, and the harbour and other accommodation here is of the greatest value to vessels forced to put in at these islands, whether disabled or otherwise. The islands of St. Michael, Fayal, Pico, San Jorge, Graciosa, and Terceira, are now connected with each other and Lisbon by submarine telegraph cable, opened for traffic August 27th, 1893. The mail steamer from Lisbon visits the islands every fortnight.

The first discovery of these islands is involved in obscurity, but the middle and eastern groups are laid down on a map dated 1351, in the Laurentian Library at Florence, showing that they were probably discovered early in the fourteenth century, by Portuguese vessels under Genoese pilots.† After this, subsequent charts show them in detail, but to Prince Henry the Navigator, son of Dom João, King of Portugal, is due the first attempt at their colonisation. Under his orders, Gonzalo Velho Cabral sailed westward in 1431, and having come across the Formigas,

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* The results of the census of November 30th, 1890, have not yet come to hand.

† See "The Life of Prince Henry of Portugal, surnamed the Navigator," by R. H. Major, F.S.A., &c., pages 235—245.

The following Table shows the mean duration of the Winds, in days, from the results of ten years observations made by Thomas Carew Hunt, Esq., at the English Consulate, St. Michael's, between January 1, 1840, and December 31, 1849 :—

Winds.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Summer Half-Year.	Winter Half-Year.	Whole Year.
North ...	1·32	1·12	1·18	1·27	1·52	0·15	2·11	0·14	1·40	2·15	2·78	3·52	7·29	11·07	18·36
N.E. ...	7·64	6·18	6·73	8·89	10·9	10·1	13·7	15·1	11·6	10·9	6·84	7·71	69·04	46·0	115·04
East ...	1·07	0·53	0·66	1·80	1·28	0·76	1·17	0·30	1·20	0·62	0·59	1·72	6·51	5·19	11·70
S.E.......	4·45	3·90	3·03	2·44	2·44	3·13	2·73	4·71	4·94	4·45	3·74	3·60	20·98	23·17	44·15
South ...	2·88	0·95	2·25	0·79	0·95	0·67	0·11	0·08	0·12	1·51	1·54	2·0	2·72	11·13	13·85
S.W. ...	6·46	6·60	9·01	4·08	3·73	4·43	4·63	2·89	3·44	4·13	6·94	5·32	23·20	38·46	61·66
West ...	1·16	1·17	1·58	1·51	2·38	1·51	2·09	1·73	1·01	1·35	1·39	1·52	10·23	8·17	18·40
N.W. ...	5·86	7·04	6·44	8·06	8·09	8·29	4·82	4·73	5·53	5·19	6·08	6·53	39·52	37·11	76·63
Calm ...	0·19	0·56	0·12	0·57	0·50	0·24	0·17	1·29	0·74	0·65	0·10	0·08	3·51	1·70	5·21
Surf on Shore	1·13	7·0	6·49	2·70	1·15	0·50	0·03	0·20	2·07	4·42	6·42	7·38	6·65	38·85	45·50

In the earlier part of this work, in the section treating of the subject, we have given descriptions of the general phenomena of the Winds and Hurricanes of the North Atlantic Ocean, and the laws by which they appear to be governed, as deduced from the numerous and careful observations which have been made at various times. In connection with that system of aerial currents, and their perturbations, we have reserved the consideration of that part of the subject which is connected with the Azores and their vicinity. It will not be necessary to recapitulate any of the principles or statements which have been before given, for which the reader must refer to 170 and following pages, and to pages 217—259.

Similar Hurricanes seem to be prevalent at the Azores, and in some measure to be governed by the same laws. The following observations on this subject, also by T. C. Hunt, Esq., will be interesting :—

" The regularity with which Gales enter these seas in the N.W. quarter, and, after crossing them, disappear at the S.E., passing through West and South, is a circumstance the knowledge of which may be highly serviceable to commanders of ships.

" The centre of a Gale, on its approach, always effects a descent in the barometer, and a change in the fall of rain. In its actual passage over the instrument, the descent generally reaches 28·50, from which a rise of one-tenth appears to take place for every 10 miles removal of the centre; so that the number of miles distance from the centre of an approaching Gale might, perhaps, be indicated by the number of hundredths shown by the barometer over the extreme of 28·50. [See (168), page 230.]

" The difference in the *fall of rain*[*] has also its regularity, the approach of the centre bringing a temporary increase, and then a cessation of the rain, which is renewed, and, in a reversed order, diminished on the removal of the centre. According to the observations made at this office, there appears to be in every Gale of wind a zone of rain about 120 miles in breadth, heaviest on the inner edge, which is about 60 miles distant from the centre; that the fall of rain decreases in proportion to the distance from this line; and that the fall on the inner edge, being about twelve-hundredths of an inch per hour, the decrease is about one-hundredth for every 10 miles of removal."

In order to follow out the views of Colonel (Sir W.) Reid, the English consul and vice-consuls at the Azores kept regular daily tables of the direction and force of the Winds, between May, 1840, and November, 1841; and the courses of twenty Gales which occurred were compiled from them, the details being given in the "Nautical Magazine," March, 1842.

From the particulars of these twenty gales,[†] there appear to be some general conclusions which may be deduced. The first circumstance developed by the inquiry is, the general direction of Storms passing across the Azores. The coincidence of this course with the Great Atlantic Current, which is a continuation of the Gulf Stream, which may every day be traced to the neighbourhood of the Azores, and which the sudden rise of water in those islands (where, having been hastened by a gale, it is suddenly checked in any locality by the operation of the wind, accompanied by a diminution of atmospheric pressure) proves to be sensibly carried beyond them, goes very far to identify the Azorean Storms with the Tropical Gales and Hurricanes traced in the able work of Colonel Reid, from the South American coast, along the course of the Gulf Stream to Cape Hatteras, in North America. There is a further resemblance in their diameters. In the chart which Colonel Reid composed of the great Hurricane of October 10th, 1780, the diameter given to it, in the latitude of the Azores, is about 550 miles. Of the Azorean Gales under consideration, four were about this diameter, eleven of about or under 650 miles, and five under 900 miles.

It seems probable that if a ship were met by a violent Gale near the Azores, her best course would be to steer, so far as the veering of the wind would allow, due North or South; that if she steered to the eastward, she would accompany the Gale, and be overtaken by the greater violence of its centre; and that by steering to the West she would sooner meet the centre, or run into a new Gale.

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[*] In the Azores a southerly wind creates great humidity in the atmosphere; a northerly wind removes it. Under the former influence, there is frequently two per cent. of water in the air; under the latter, less than one per cent.

[†] The commencement of these gales was on the following days, viz.:—1840, June 4th, Aug. 19th, Oct. 3rd, Oct. 7th, Oct. 9th, Nov. 2nd, Nov. 11th, Nov. 14th, Nov. 28th, Dec. 1st, Dec. 6th, Dec. 11th, Dec. 15th, Dec. 27th; 1841, Jan. 11th, Feb. 3rd, Feb. 11th, March 6th, March 19th, Sept. 8th, and Sept. 18th.

Whatever may be the cause of the occasional deflection of the Azorean Storms, whether it arises from collision with another Storm, or from atmospheric gravitation (the radiation of heat from the islands being always very great), the uniform effect appears to be a diminution of their progressive velocity, and frequently an increase of their rotatory force.

But as far as these effects can be foreseen, from a knowledge of the deflection (presuming it always to be accompanied by a slower progression), it is worthy of observation, that the deflection never appears to take a turn to the northward, but always to the South. If this be true, the safest course for a ship in these gales is to the North, unless there are very cogent reasons for a departure from this supposed rule.

The Currents are irregular among the Azores, generally weak, and they appear to be mainly due to the extension of the Gulf Stream. They sometimes attain a velocity of 20 miles per day.

Tides.—The flood comes from S.W. by S., but the rise at springs is small, varying from 6 ft. at Santa Maria to 3½ ft. at Flores.

Captain E. Boid, R.N., remarks that "the navigation of the Azores is remarkably free from danger, and without any difficulties, except such as arise from the variableness of the weather, and the currents to which their vicinity is liable, which occasionally baffle, in a most extraordinary degree, the attempts of vessels either approaching or sailing through them. The shores of all the islands are bold all round, and generally without rocks, save such as are distinctly visible and easily to be avoided. The following are the only exceptions which it may be considered necessary to recommend to the caution of navigators, viz.:—The Formigas, or Ants; Tulloch Rocks (?); Dollabaret's Shoal; Chapman Rock; and the Goat Islands and Friars Rocks off Terceira.

"I scarcely know of any group of islands more liable to sudden storms, squalls, and changes of weather, than the neighbourhood of these. No continuous fine weather may be expected at these islands until May, or even later, from the summer solstice to the autumnal equinox; between which periods frequent long calms prevail, or light baffling airs. In 1832, a British frigate beating from Terceira to Fayal did not arrive at Horta until the 10th day.

"It is a most remarkable fact, that in all the operations of nature, and the whimsical forms assumed by her in the different convulsions that have occurred in this archipelago, no creek, inlet, or bay, has been formed in any one of them to constitute a safe port, without the aid of art; nor has any island, or set of islets, been thrown up in such a position as to present a protected landlocked anchorage."

SAN MIGUEL, or ST. MICHAEL'S, the largest and most important island of the Azores, is 34½ miles long N.W. by W. and S.E. by E., by from 4 to 8 miles in breadth, its narrowest and lowest part being between Ponta Delgada on the South, and Ribeira Grande on the North, making the island appear as two at long distances. It mainly consists of mountains, hills, and valleys, which are evidently due to volcanic energy, affording a most charming variety of beautiful and interesting scenery.

The eastern part is a mass of mountains culminating in the *Pico da Vara*, 3,570 ft., the highest point of the island. Farther to the westward, in the centre of the island, is the *Serra da Agoa do Pao*, elevated 3,070 ft., and westward of this the land declines in height, but has numerous small peaks, among which the highest are *Pico do Fogo*, 1,023 ft.; *Pico da Pedra*, 1,260 ft.; and *Serra Gorda*, 1,570 feet. The N.W. end of the island consists of one vast crater, known as the *Caldeira das Sete Cidades*, on the S.E. rim of which the *Pico da Cruz* rises to an elevation of 2,777 ft. above the sea.

The mountains and hills clearly indicate, by their conical figure, and the cavity at their summits, their being the production of fire, and bear unequivocal marks of the effects of this destructive agent, in an accumulation of lava, scoriæ, pumice, and volcanic sand. Externally, the volcanos appear extinguished, but they are supposed still to burn internally and invisibly. Of this, the *Caldeiras*, or fountains of boiling water, in the Valley of Furnas and other parts are evident symptoms. There have existed three principal craters, whose vertices now form three great lakes, situate towards the centre and the N.W. and southern portions of the island. From those craters vast mountains have been thrown up; and, in proportion as these ceased to vomit forth matter, partial eruptions burst out, and formed the lateral hills and declivities, which extend themselves in every direction from the mountains surrounding the lakes. The cessation of fire from the different craters has been attributed to water, which appears to have gained access to each, and suddenly extinguished the effervescence of its mineral contents; and the fire now seems confined to several spots, where it operates only in boiling the water with various degrees of activity and force.

The island, in fact, seems to be of such a structure and conformation, that the water passes freely throughout its volcanic caverns, and is easily forced out without shaking or disturbing the earth. Of these extinguished craters, that of the *Sete Cidades*,* in the N.W. part of the island, is the largest, being about 2½ miles in diameter; the interior is occupied by two lakes, and the ridge bounding it is nearly of equal height throughout, except where it rises into peaks, and on the N.W. presents a gap between two hills, 1,620 and 1,770 ft. high. The second crater, called the *Lagoa do Fogo*, is in the middle of the island, and situated in a gloomy valley on the East side of the Serra da Agoa do Pao, surrounded by mountains of pumice. The *Lagoa das Furnas*, the third crater, is elevated 864 ft. above the sea (about the same as that of the Sete Cidades), situated among picturesque mountains, and in this valley are the boiling springs, where a fine range of baths has been erected for the benefit of invalids and others. Eastward of the Valle das Furnas the mountains of pumice increase in height, forming a continuous range as far as the *Pico da Vara*, the summit of which is 3,570 ft. above the sea, and is the only place on the island where snow is ever found.

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* No explanation can be given of the origin of this appellation, though there may be some curious connection between this and the *Seven Cities* of the fabled island or continent of *Atlantis* or *Antilia*.

Though only 44 miles distant, and visible in clear weather, the existence of this island was not known till the year 1444, when an escaped prisoner sighted it from the hills of Santa Maria. Cabral first landed on the island on May 8th of that year, near where Povoação now stands, and named the island *San Miguel*, that day being the festival of the Apparition of the Archangel Michael. Forming a small settlement here, he set sail for Lisbon, to make preparations for colonizing the extensive plains which appeared to him to be so capable of being highly cultivated. Returning in the following year, with everything necessary for the establishment of his colony, he reached the island on September 29th, but what was his surprise, when in place of the lofty mountain on the western end of the island, he found an immense crater, and passed fields of floating pumice and trunks of trees. On landing, the affrighted first settlers told him of violent earthquakes, and the covering of the land with hot ashes from the volcano, now known as the *Caldeira das Sete Cidades*. He, however, landed his colonists and stores, and settlements were gradually formed throughout the island, and *Villa Franca* was fixed on as the seat of government.

From this time the island remained tranquil until October, 1522, when an eruption overturned the two hills *Sorical* and *Rubical*, and entirely destroyed the town of Villa Franca, and 4,000 inhabitants also lost their lives. In 1538, an island arose and disappeared, 3 miles off the N.W. point. In July and August, 1563, several eruptions occurred, covering the island with burning ashes, some of which fell in the North of Portugal. One in the Valle das Furnas, at the *Lagoa Secca;* another near the centre of the island, the crater of which is now occupied by the *Lagoa do Fogo*, a stream of lava flowing into the sea at Agoa do Pao; and another at the *Pico do Sapateiro*, above Ribeira Grande, the hill disappearing, and a large stream of lava ran into the sea.

In July and August, 1591, seven successive shocks from earthquakes occurred, when Villa Franca was again destroyed. In September, 1630, two hundred persons lost their lives from earthquakes, between Povoação and Villa Franca, when several adjacent cones emitted streams of lava; and a great eruption occurred in the Valle das Furnas, drying up a lake now known as the *Lagoa Secca*, and sending forth vast volumes of dust and ashes. In July, 1638, an island was again formed and disappeared, 3 miles off the N.W. point. In September, 1652, some hills near Ponta Delgada threw up an immense quantity of stones and cinders, spreading destruction around. In 1691, after some very violent earthquakes, several small islets appeared not far from the coast.

In November, 1707, a torrent, attributed to the breaking of a waterspout, fell on Ponta Delgada, and caused great damage. In November, 1713, earthquakes and a lava flow occurred near Ginetes, on the N.W. coast. In 1719, the island off the N.W. point again appeared for a short time. In December, 1720, a succession of violent earthquakes caused much damage, and they were also felt in Terceira, while a submarine eruption between the two islands caused the formation of an island which did not disappear for three years. On October 5th, 1744, another fall of water occurred, washing down the valleys of Povoação and Fayal de Leira, carrying away great parts of two villages. The cause of these floods still remains unexplained.

The great Lisbon earthquake in 1754 was also felt here, but there was no eruption, and in 1755 shocks were again felt. In October, 1773, earthquake shocks and a violent storm occurred. In 1806, a mass of rock slipped from the valley of the Furnas, leaving a chasm 100 yards in diameter; and in 1811 a similar fall occurred close to the same place. In the night of August 11th to 12th, 1810, the whole island was shaken and many buildings damaged by repeated shocks, and the *Pico de Ginetes*, on the N.W. coast, burst into eruption; flames also issued from an orifice, like a crater, at the N.E. end of the island. The eruption of Sabrina Island, in 1811, is described below. In 1838, another landslip occurred at the Furnas. On December 5th, 1839, a rise of the sea, like that in 1755, washed down several houses, &c., on the South coast.

The last severe earthquake which was felt here was that which devastated Terceira, in June, 1841, of which a description is given in the notice of that island; though, since that time, slight shocks were felt in 1849, 1852 and 1853, 1862, 1882, and 1884.

The above is an account of the principal eruptions, and it will be noticed, as a curious fact, that all, or nearly all, occurred between the months of June and December, chiefly in July, August, and September.

Sabrina Island.—The circumstances attending the formation of this singular island are as follows.* On the night of February 1st, 1811, a most awful and tremendous explosion of smoke and flame issued from the sea, off the western end of St. Michael's, to the S.W. of Point Ferraria, and due West from the Pico de Ginetes, at about 1½ mile from the nearest part of the shore. From the depth of about 40 fathoms issued smoke, fire, cinders, ashes, and stones of immense size, and innumerable quantities of fish, some nearly roasted, and others as if broiled, floated on the surface of the sea toward the shore. Thus a dangerous shoal gradually formed, on which the brig *Swift*, with all her crew, were lost, before the existence of the shoal was known. This shoal afterwards seems to have completely disappeared, as in Captain Vidal's survey of 1844, a depth of 125 fathoms was found near its site.

On June 12th, 1811, the crew of H.M. sloop *Sabrina* observed two or three columns of white smoke rising from the sea, off the West end of St. Michael's, which they supposed to arise from an engagement, and made sail toward it, but were disappointed by the wind dying away; as the smoke continued to ascend, with volumes of flame, they then concluded it was a volcano. Next day they were close in with the land, and found the volcano still raging, about 1 mile North of Point Ferraria, or nearly 2½ miles N.E. of the shoal formed in the early part of the year. On landing at Ponta Delgada on the 13th, they learned that the smoke was first observed from the island on June 8th; two or three days previous to which, repeated shocks of earthquake had been felt in the town, which threw down several cottages and portions of the cliff toward the N.W., so that destruction was feared on the island; but these ceased as soon as the volcano broke out.

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* From the "Narrative of the Eruption of a Volcano in the Sea off the Island of St. Michael," by Captain S. Tillard, R.N., in the "Philosophical Transactions of the Royal Society," 1812, pages 152—158.

On the following morning, June 14th, Captain Tillard, of the *Sabrina*, accompanied by Mr. Read, the resident English consul, with two other gentlemen, proceeded overland to the cliff nearest to the volcano, where they were between 300 and 400 feet above the level of the sea. The first appearance it presented was that of an immense body of smoke revolving on the water almost horizontally, in varied involutions; when suddenly would shoot up a column of the blackest cinders, ashes, and stones, in form like a spire, and rising to windward at an angle of from 10° to 20° from a perpendicular line. This was rapidly succeeded by a second, third, and fourth, each having greater velocity, and overtopping the preceding one, till they had attained an altitude as much above the level of the eye on the cliff as the sea was below it. These bursts were accompanied by explosions of the most vivid lightning, with a noise like the continual firing of cannon and musketry intermixed; and, as the cloud of smoke rolled off to leeward, it drew up the waterspouts, mentioned below, which formed a beautiful and striking addition to the scene.

About noon on the same day they observed the mouth of the crater just showing itself above the surface of the sea, where there was formerly upwards of 30 fathoms of water. At 3 p.m., same day, it was about 20 feet above the surface of the water, and the diameter of the crater apparently about 400 or 500 feet.

On the 15th, the *Sabrina* went as near to the volcano as she could with safety, and found it still raging, throwing up, from under the water, large stones, cinders, ashes, &c., accompanied by several severe concussions. It was then about 50 feet in height, and two-thirds of a mile in length, and some of the stones fell a mile distant from the volcano. The smoke drew up several waterspouts, which, spreading in the air, fell in heavy rain, accompanied with vast quantities of fine black sand, which completely covered the *Sabrina's* decks, at the distance of 3 or 4 miles. On the 16th they proceeded on a cruise, leaving the volcano about 150 feet high, and still raging as formerly, and continuing to increase in size.

On July 4th, they again visited it, and found that a complete island was formed, and perfectly quiet. The captain and several officers landed upon it, and found it very steep, and its height was about 250 feet. It was still smoking in many parts, and very hot, and they walked round it on a narrow beach of black ashes in about 12 minutes. The crater, filled with nearly boiling water, was almost level with the sea on the side towards the coast. The island was very steep-to, 25 fathoms being found at 20 or 30 yards from the beach.

Subsequently the islet fell by degrees into the sea; and, in the middle of October, no part was left above water, but a dangerous shoal remained in the place which it had occupied. In February, 1812, smoke was discovered still issuing out of the sea near the spot.

In June, 1841, Captain Vidal, in H.M.S. *Styx*, anchored in 16 fathoms, on the site of Sabrina Island, and found that the least water thereon was

15 fathoms. In 1886, the schooner *Chica*, while fishing, searched the spot, and found no bottom at 200 fathoms.

The Island of St. Michael has an area of 224 square miles, of which only about one-third is under cultivation, chiefly yielding maize and other grain, beans, sweet potatoes, flax, and oranges, the excellent quality of the latter being well known. In the time when the orange trade was at its best, about 500,000 boxes, each containing 350 to 400 oranges, were exported annually. Large numbers of pine-apples are also raised under glass and exported. To provide the material for the fruit boxes, large areas have been planted with pine trees, cedar, eucalyptus, acacia, &c., which flourish in soil apparently barren. Supplies of pure water are everywhere abundant.

The Climate is mild and equable, the mean winter temperature being 61° F., and that of summer 69½°, though of course the variation is greater among the mountains, and frost and snow are experienced on the summits in winter. Near the coast the air is usually laden with moisture, and is consequently rather relaxing. The rainfall is very irregular, but averages about 40 inches annually.

St. Michael's contains one city, five principal towns, and fifty-four parishes, together numbering about 120,000 inhabitants, the agricultural population being very poor, but quiet and cheerful. A considerable amount of emigration to Brasil and the United States goes on from this and the other islands of the group.

In clear weather, the high land of St. Michael's will be sighted when over 50 miles distant, and on a close approach the island affords a fine prospect of mountains and hills, in many parts well wooded. As a rule, the coast consists of magnificent precipitous cliffs, but in some parts the fertile land slopes down to the sea, and on the summits of the cliffs, or on the lower ground, are seen the towns and villages of white, pink, and yellow houses.

The coast, being bold all round, may be approached without fear, as there are no rocks or dangers more than a quarter of a mile from the shore, excepting some rocks at the N.W. end, off the Bay of Mosteiros. The bank of soundings nearly conforms to the outline of the island, as shown by the chart, but projects farther off the N.E. end, where the 100-fathoms line is found nearly 6 miles off shore. In case of need, with off-shore winds, anchorage might be found all along the southern and eastern coasts, but sailing vessels must beware of getting embayed on the northern side of the island, as there is no good anchorage there.

On approaching the N.W. end of the island from the westward, the appearance is very unpromising, as it presents barren mountains of stupendous bulk, with a coast like many ramified pillars of basalt, exhibiting, at the top, a few trees of stunted growth. The impression made by a scene of rough and craggy cliffs, is, however, soon dissipated by a pleasing contrast on the southern coast, as this is adorned by luxuriant vegetation. Open pastures, bounded by woods, vineyards, and corn-fields, interspersed with orchards of orange and lemon trees, and the white buildings of the pineries, everywhere meet the eye, and afford a landscape, extensive and various, which will always, in clear weather, be seen with delight. Every available plot of ground appears to be cultivated, many patches even on the face and at the foot of the cliffs, these patches being surrounded by lines of a tall sort of reed, sheltering the crops from the winds, and at a distance having a peculiar appearance.

The eastern end of the island consists of stupendous cliffs rising abruptly from the sea to the height of many hundreds of feet, and towering above these is a mass of mountains, culminating in the *Pico da Vara*, elevated 3,570 feet.

The distant view of St. Michael's is sometimes deceiving, in consequence of the haze which frequently covers the land; and the following observations will be useful in explaining any uncertainty which may be felt in making this island. Captain Midgley says:—"On September 26th, 1840, at daylight, I hauled up on a N.E. by E. course, to make St. Michael's, with a moderate S.S.E. breeze and fine clear weather. At noon, saw the West end of the island bearing N.E. ½ E., and although the weather was apparently clear in every other part, only a small portion of the land could be seen, the remainder being covered with clouds and haze. The above bearing and the observed latitude placed the ship 31 miles from the West end of the island. At 3 p.m. saw the eastern extremity of the land distinctly, but could not make out the land in the centre of the island; indeed, the haze which hung over it so completely deceived me for some time, that I considered *two* islands were in sight, and that I must have made some mistake in my observations; but, on drawing nearer to the land, as the sun approached the horizon, the fog dispersed, and I had a good sight of the centre of the island also. After sunset, the evening was fine, with serene clear weather.

"On December 31st, 1841, I intended to pass to the southward of St. Michael's, but a scant wind obliged me to bear up for the West end of that island, on passing which it again had the appearance of two separate islands, with well-defined extremities to each, the land in the centre being covered with fog and haze. When seen from the northward, on the following day, it had again the same appearance, that of two separate and apparently well-defined islands."

ARNEL POINT, the easternmost part of St. Michael's, is cliffy, with a broad beach around its base, and forms on its South side the small bay or port of *Nazarete*, in front of the village of the same name, but it is unsheltered, and the bottom rocky.

The Lighthouse on Arnel Point is situated on the eastern side of the building which serves as the keeper's dwelling. It is an octagonal tower, 39 ft. high, the base of which is 183 ft. above the sea. The light is *fixed bright*, varied by a *flash* every 2 minutes, elevated 219 ft. above the sea, and visible 18 miles; the flashes are visible 25 miles. Position, latitude 37° 49′ 25″ N., long. 25° 8′ 30″ W.

Adjoining the lighthouse is the *Signal Station*, in telegraphic communication with the city of Ponta Delgada (see page 719). Signals are made in case of a storm being expected.

At 1 mile S.S.W. of Arnel Point is *Marqueza Point*, a steep cliff 400 ft. high, and at 1½ mile farther on, to S.W. by S. ½ S., is *Lombo Gordo Point*, a bold basaltic headland 1,347 ft. high. Between this and *Retorta Point*, 3 miles to S.W. by W., the cliffy coast is fronted by a few rocks, and here is the village of *Agoa Retorta.* This district was formerly very fertile, but in 1563 it was buried under thick layers of pumice. Between Ponta Retorta and Fayal Point, 1½ mile to W. by N., the coast forms a bight, with a sandy beach at the foot of the cliffs, and here is the village of *Fayal,* through which runs the stream called *Moinhos River.*

Povoaçao.—Between Fayal Point and Ribeira Quente Point, 4 miles to W.N.W., the coast forms a slender bay, with lofty cliffs, in a break near the centre of which is the town of *Povoação,* where there is a small stone pier for the use of the fishermen. At the back of the town is an extensive cultivated plain, bounded by high mountains, and on which are several long lines of cottages called *lombos,* forming one of the most populous and prosperous parts of the island. At less than one-quarter of a mile off shore, with the church bearing N.N.W., is a sunken rock on which the sea usually breaks, with 3 to 7 fathoms close around it. In case of necessity, vessels can anchor in this bay, depths of 9 to 53 fathoms being found within three-quarters of a mile of the shore, good bottom of sand and gravel.

Ribeira Quente Point is a narrow rocky projection, close westward of which landing may be effected, eastward of the beach on which stands the village of *Albufeira* near the stream named *Ribeira Quente* (warm). This stream takes its rise at the hot springs in the Valle das Furnas (page 711). *Lobeira Point* lies nearly 1 mile westward of Albufeira, and several rocks lie off the cliffs between. *Lobeira Rock,* a few feet above water, lies nearly one-quarter of a mile S. by W. ½ W. from the point, with 5 to 14 fathoms close around it. At 2½ miles W. by N. from Lobeira Point is *Garça Point,* with a village above it, and here there is landing. From hence the cliffy coast trends 2¾ miles N.W. by W. ¾ W. to *Area Point,* on which is a small fortress.

VILLA FRANCA, once the chief town of St. Michael's, is beautifully situated, extending about half a mile along the cliffs, between Area and Forca Points, and is fronted by reefs and rocky ground, reaching about 2 cables off. The country around is highly cultivated, and at one time large quantities of oranges were exported. Provisions of all kinds and water can be obtained here.

The *Ilheo* or *Islet of Villa Franca,* about 350 yards in diameter, lies 3 cables S.W. by S. ½ S. from Forca Point, with depths of 3 to 4½ fathoms in the channel between, bottom of sand or rock. This is a great natural curiosity, being the crater of an extinct volcano, with an extremely rugged and irregular appearance. It rises abruptly from the sea, its western and highest side attaining an elevation of about 400 ft., and off its South side is a remarkable detached rock, known as the *Pyramid.* The Ilheo is formed of a kind of conglomerate of lava, in detached pieces, sand, débris, and pumice-stone, and on the East side it seems gradually wearing away. In its interior there are cultivated terraces, with reeds planted for shelter, and they grow not only potatos and maize on it, but there are even a few vines, and some fine heath 3 to 4 feet in height. There is abundance of fish in and around the islet.

Within, the sides of the crater slope down to a circular basin about 200 yards in diameter, with depths of 3 to 6 fathoms, bottom of sand and small stones, called the *Porto do Ilheo.* On its N.E. side, fronting the town, there is access to this basin by a channel from 20 to 30 feet wide, with a depth of 12 to 13 ft. in it at high water. This place is resorted to by small vessels for the purpose of careening, &c. It affords shelter from gales between West and South; but as a part of the S.E. side is low, the wind from that direction throws a heavy swell into it, and renders it dangerous; and vessels caught by this wind must be scuttled, as the only way to save them.

The Roadstead of Villa Franca is only safe in fine weather, and, with southerly winds, vessels must be prepared to put to sea. There is anchorage in 9 fathoms, sand and gravel, with the N.E. point of the Ilheo bearing W. ⅝ N., the Castello N. ⅞ W., and Area Fort N.E. ⅜ N., the two latter distant about one-third of a mile. Another berth is in 10 fathoms, sand, with the Castello bearing N.E. by N. ⅞ N., distant nearly 4 cables. Vessels should not venture nearer the foul ground extending off the town, and when southerly winds may be expected it is advisable to lie farther off; the depth increases gradually to the 20-fathoms line, which runs about 9 cables off the shore.

Small vessels can lie close off the N.E. side of the Ilheo, in depths of 4 to 5 fathoms, sheltered from winds westward of South; they moor North and South, with a hawser to the islet.

Pyramida Point, 11 cables N.W. by W. ¾ W. from Forca Point, is a narrow projecting point from the high red cliffs, with a high pointed rock off it, and foul ground extends nearly 2 cables beyond this. In bad weather the sea breaks heavily on it, and on a patch of 6 ft. lying from 1½ to 2½ cables S.W. by W. ½ W. from the point.

Galera Point, the southernmost point of St. Michael's, lies 2 miles W. by N. ¾ N. from Pyramida Point, the coast between being cliffy, with a few rocks off it. A sailing vessel approaching Ponta Delgada from the eastward should give this point a good offing, as the high land above it often occasions a calm, and rocks extend about 2 cables off it. Between Galera Point and *Agoa Point,** a bold cliff 1 mile to N.W. by N., the coast forms a bay, at the head of which is *Port Cabassos,* a cove where landing can be effected in front of the town of *Agoa do Pao.* Westward of this the island becomes lower, and a multitude of small volcanic cones gives a singular appearance to the prospect.

From Agoa Point the cliffy coast trends 2½ miles to the N.N.W., and then turns to W. by N. to *Alagoa Point,* a low black projection of lava. *Port Carneyros,* eastward of Alagoa Point, is a cove where landing may be effected near the town of *Alagoa.* Close to the cove is a distillery, the tall chimney of which is conspicuous.

Port Caetano, 1¾ mile N.W. of Alagoa Point, is a small bight, off which is the *Quarantine Roadstead.* Vessels in quarantine anchor in 12 fathoms, sand, one-third of a mile off, or in 30 fathoms, half a mile off. *Rosto do*

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* A sunken rock was reported to lie half a mile S.W. of Agoa Point, and 1⅛ mile N.W. by W. ½ W. from Galera Point. It was not found during the survey of 1844, and subsequent searches for it have been in vain. It probably does not exist.

Cão Point, nearly 1 mile West of Port Caetano, is an isolated projecting bluff of yellowish lava, 78 ft. high, with a depth of 5 fathoms close off it; the telegraph cable from Lisbon is landed here. From hence to San Bras Castle the coast is fronted by rocks and shoal ground extending about 1 cable off.

The City Front.—Nearly 1 mile W.N.W. of Rosto do Cão Point is an inlet among the rocks called *Calpeta*, where the fishermen find good accommodation for landing and drawing up their boats. Above this rises a small hill, on the summit of which is the church of *Mae de Deus*, at the eastern end of the city. At 2¼ cables W. by S. of the Calpeta is *San Pedro Point*, on which is a battery, and a detached 3-ft. patch lies 1 cable S.W. of it. At 2 cables farther westward is the *Custom-house*, on the West side of which is the landing-place. At 2 cables W. by S. of this is the *Arenal*, a small basin with 10 ft. water in it, much used by the fishermen, and affording good landing at all times. Its western side is formed by the walls of *San Bras Castle*, at the western end of the city; this fortress was founded in 1552.

The City of PONTA DELGADA, containing about 20,000 inhabitants, is not only the chief port of St. Michael's, but also of the whole group of the Azores, and is the third in importance of the cities of Portugal. From sea it has a very picturesque and pleasant appearance, its white houses and numerous churches being visible afar off, and backed by orange groves and gardens, and well cultivated hills, of which *Serra Gorda*, 1,570 feet in height, has a summit like a saddle. It extends about 2 miles along the shore, and the houses are well built, and the streets are clean and lighted with gas. There is also a large hospital, into which strangers are readily admitted; and there is a spacious floating lazaretto in the harbour. The port is rapidly rising in importance, on account of the shelter afforded by the breakwater now on the point of completion, and the number of vessels calling here for coaling and other purposes is largely increasing every year. The establishment of telegraphic communication with Europe still further adds to its convenience as a port of call, &c. The most important shipping firm on the island is Messrs. Bensaude and Co., who have a large coaling depot and all the appliances necessary to shipping.

Provisions are good and plentiful, at moderate prices, there being markets for the sale of fresh meat, fish, fruit, and vegetables. Fresh water, of excellent quality, is brought off to the shipping in boats containing 1,200 to 2,000 gallons, and furnished with pumps. *Coal* can be supplied to steamers at the rate of about 40 tons an hour, usually by lighters; Messrs. Bensaude and Co. have large stores on the inner side of the breakwater, capable of containing about 15,000 tons.* Vessels requiring coal, when approaching the harbour or one of the Signal Stations, should hoist the Answering Pennant over Flag N of the International Code, the name, and quantity required, *to ensure quick dispatch.* The port expenses to vessels calling for coal, provisions, &c., are merely nominal.*

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* In 1890, the steamer *Boston* put in here for coal, and Capt. Doane states as follows:—"At 9 a.m. I made arrangements for coaling, and by 5^h 30^m p.m. we had 300 tons on board, and were ready to leave. We had a boat in attendance all the time we were in port, yet our expenses of boat-hire, customs, and all port charges, amounted to the sum of only £2 17s."

There is regular mail communication with Europe, and the island is connected with Lisbon by means of a submarine Telegraph Cable, laid in August, 1893.

Lying in the harbour is a floating dock, capable of raising a vessel weighing 1,400 tons; it is 184¼ ft. long, 43¾ ft. wide, and the greatest draught it will admit is 14 feet. It has been proposed to construct a slipway.

Repairs can be undertaken both for iron and wooden vessels, and steamers can have ordinary repairs to their engines or boilers efficiently executed. Large vessels have here been enabled, under shelter of the breakwater, to fit spare shafts or propellers; and on the quay are some capacious warehouses, for receiving cargo if necessary, with powerful cranes. Vessels drawing 21 ft. can lie alongside them at low water, and it is intended to construct other quays, alongside which the largest vessels will be able to lie afloat. Steam-tugs will render assistance to vessels, if necessary, at moderate charges, and trained divers can be obtained. A powerful twin-screw tug, capable of towing the largest vessels any distance, is also kept in readiness for local or distant service. A powerful steam pump is available at a moment's notice.

The Breakwater sheltering the harbour is a noble work, commenced in 1861, and now nearly completed. It is of most substantial construction, its base being 150 yards in breadth, surmounted by a solid wall, 16 to 20 feet in thickness, rising to a height of 33 ft. above high water. Altogether about 5,000,000 tons of stone have been required for its formation. It leaves the shore near the Castle of San Bras, at the western end of the city, and thence extends 860 yards in a S.E. ⅝ E. direction, when it gradually curves round towards E. ½ S. for a further distance of 500 yards, into a depth of 12 to 14 fathoms at low water, the outer submerged works being only a few feet below the surface at low water, and vessels should not attempt to pass westward of the buoys marking its extremity. Between this and San Pedro Point, to the N.N.E., the entrance of the harbour is about 3½ cables in width, but shoal water extends nearly a cable off the city front, the depth diminishing gradually towards it.

In former years the small vessels engaged in carrying on the trade of Ponta Delgada were obliged to lie in an open roadstead, exposed to the risk of shipwreck in the case of strong winds suddenly setting in between W.N.W. and E.S.E., round by South, and were forced to slip their cables, and endeavour to proceed to sea to await a favourable change of wind. Wrecks and loss of life were of annual occurrence. Now vessels of any size can moor under shelter of the breakwater, completely protected from every wind, to receive or discharge cargo at all times, being only exposed to a little swell with winds from the south-eastward. The stability of the work has been severely tested by storms, during which vessels have lain here in perfect security. In the furious and prolonged Hurricane which lasted from December 26th to 29th, 1887, no less than 43 vessels, varying in size from 200 to 2,000 tons, including 6 steamers, found a safe refuge here.

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* *Port Dues.*—Vessels from abroad pay 6 reis per ton per day if staying less than three days; for the next five days, or fraction of this time, the charge is 10 reis per ton; for more than eight days up to one month, the charge is 10 per cent. per day on the amount paid for the first three days; and above one month, 5 per cent. per day on the same amount. Whalers, and Portuguese vessels up to 400 tons, are entitled to an abatement of 20 per cent. on these charges. There are also small charges for the use of mooring buoys and bollards, anchors and chains, and if mooring alongside the quay. Vessels also pay a light due of 1 reis per ton.

Vessels putting into the harbour for repairs, coal, orders, or supplies, are exempt from all port charges, and are allowed to take passengers on board up to the number of twelve.

Light.—On the centre of the breakwater, more than 750 yards within the submerged extremity of the works, is a red iron tower, 26 ft. high, in which is shown a *fixed red* light, elevated 48 ft. above high water, and visible 9 miles in clear weather. The position of this lighthouse is lat. 37° 44′ N., long. 25° 40′ 30″ W.

On the completion of the breakwater this lighthouse will be removed to the outer extremity, but till this is done commanders of vessels approaching by night must bear its present position well in mind, and give it a very wide berth, for fear of grounding on the submerged works.

A *Beacon Buoy*, bearing a *fixed red light*, is placed at the submerged extremity of the works, and about 1¼ cable eastward of the visible extremity of the breakwater. No vessel should attempt to pass westward of this buoy, or of a *bell* buoy moored near it; and it must also be remembered that in stormy weather its light may possibly be extinguished.

All vessels entering the harbour must take a pilot on board, unless driven in by stress of weather or other unavoidable circumstances. Vessels anchoring in the roads are exempt from pilotage, but they are not allowed to anchor in such a way as to obstruct the free access to the harbour.

The fairway into the harbour is marked by two lines of *buoys*, placed on either side. Vessels entering leave the *red* buoys on their starboard side, and the *black* buoys on their port side. The depth in the harbour varies from 12 to 5 fathoms and under, gradually decreasing towards the inner part. The bottom consists of sand over basaltic rock, and is good holding ground, but it is necessary for vessels to make fast to the quays or to moorings laid down in the harbour. It is estimated that the harbour could afford shelter to over 100 vessels if moored in tiers, including a fair proportion of ships of the largest size, such as transatlantic mail steamers and men-of-war.

Tides.—It is high water at Ponta Delgada, on full and change, at $12^h\ 30^m$; springs rise 7½ feet.

Signal Station.—Near the southern angle of the Castle of San Bras is a wooden erection, used as a Signal Station, with which vessels can communicate by means of the International Code.

Directions.—Few directions are necessary for approaching the harbour, the coast being safe to approach to a reasonable distance. With the wind from E.S.E., S.E., and South, vessels must stand well to the eastward, in order to come in with the wind on the port quarter. The most conspicuous marks from seaward are the churches, the prison (a large white building on the North side of the entrance), and the distillery chimney at the western end of the city. Mae de Deus church stands on a small hill at the eastern end. At night, the light on the breakwater forms a good guide, and when bearing W.N.W. will lead towards the head of the breakwater; it should not, however, be approached within half a mile on this bearing, nor should vessels attempt to pass westward of the buoys marking the submerged end of the works, without the aid of a pilot.

The Roadstead off the city affords good anchorage, where vessels may ride safely, except during gales from E.S.E. to W.N.W., round by South, when complete shelter will be found under the breakwater. The outer part has depths of 20 to 30 fathoms, from 7½ cables to 1 mile off shore, but, in fair weather, vessels lie in 12 to 18 fathoms, within 3 cables of the extremity of the breakwater, or in 8 to 12 fathoms off the harbour entrance.

Should a sailing vessel be forced to quit the anchorage in winter, by a southerly gale, and unable to enter the harbour, it will be best to round the western end of the island, and await a shift of wind from the N.W., which commonly succeeds a S.W. wind. Thus may the roadstead be easily regained; but, by running to the south-eastward, it may be ten days, or more, before you can beat back to the road. In beating up, keep close inshore, only avoiding the rocks which lie near it.

Immediately westward of San Bras Castle the coast is low and rocky, and about half a mile distant is *Ponta Delgada* (*thin* or *sharp* point), on which stands the church of Santa Clara, eastward of which is a small bay with a black shingly beach. Close to this are the quarries for the breakwater works.

The Coast trends 9½ miles N.W. by N. ¾ N. from Ponta Delgada to *Candelaria Point*, consisting of a continuous line of magnificent cliffs, on which may be seen the villages of *Relva* and *Feteiras*. Towering above the latter are the furrowed sides of the *Caldeira das Sete Cidades* (see page 711). The cliffy coast continues for 2 miles N. ½ E., passing *Ginetes Peak*, to *Ferraria Point*, the western extremity of St. Michael's, a low dark rugged projection, on which stands *Camarinhas Peak*, elevated 687 feet; a rocky ridge extends off the point.* From hence, inaccessible cliffs extend for 1½ mile E.N.E. to *Varzea Point*, which has a ridge of rocks extending 3 cables North of it.

A *Signal Station* is established on Ferraria Point, in telegraphic communication with Ponta Delgada.

Mosteiros.—Between Varzea Point and Mosteiros Point, 1¾ mile to N.E. by E., the coast forms a rocky bight, along the northern side of which is the large village of *Mosteiros*. The coast here is fronted by rocks and reefs, forming a little harbour only fit for boats; the outermost and largest rock, known as *Mosteiros Island*, lies nearly half a mile off the shore at the southern end of the village, and is high, steep, and smooth at its summit, with an aperture through which the sea passes from one side to the other. Near the village is a spring of hot water, rising among the rocks in the sea. *Mosteiros* or *Matogos Point* is low and projecting; here the rocks extend about one-third of a mile off, and a ridge of 2 to 7 fathoms is reported to reach 3 miles off, the sea breaking at that distance.

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* Toñño states that a rocky ridge projects to the S.W. of Ferraria Point, with 7 to 10 fathoms over it at 3 miles off shore, and that a heavy sea rises over it, very high. In 1892, the United States Hydrographic Office description states that the ridge extends one-third of a mile off, and that the sea often breaks at a greater distance. In the latest charts a depth of 15 to 20 fathoms is shown at one-quarter of a mile off. It must be remembered that this locality has been the scene of much volcanic disturbance, as narrated previously on pages 712 and 713. Vessels should not approach the N.W. coast within a depth of 20 fathoms.

The North Coast of St. Michael's forms a large bight, the shores of which are rocky, and in parts cliffy, but not so elevated as those on the South coast. This side of the island is well cultivated, and yields large quantities of wine. Ribeira Grande is the principal town.

Bretanha Point, the North point of St. Michael's, consists of cliffs 380 feet high, within which is the long village of *Bretanha*, the country around being highly cultivated, with pasture land. It lies nearly 2 miles E. ¾ S. from Mosteiros Point, the rocky coast between forming *João Bom Bay*, near the bottom of which appears a very sharp-pointed mountain, called the *Pico de Maffa*, which serves as a very useful mark for this coast.

Between Bretanha Point and Port Capellas, 5½ miles to S.S.E., the coast is cliffy, with a few off-lying rocks. *Lombinha Rock*, lying 2½ cables off shore, at three-quarters of a mile to the E.S.E. of Bretanha Point, is a large flat rock above water, with sunken rocks around. About 1 mile S.E. of Bretanha is the village of *Ajuda*, with a conspicuous church, and here there is landing eastward of *Costa Point*, at the foot of the *Pico Vermelho*. At 3½ miles farther on is the village of *San Antonio*.

Port Capellas is a small bay or cove, westward of the bold cliffy headland called *Morro das Capellas*, which shelters it from S.E. gales. It has depths of 5 to 14 fathoms, bottom of fine sand, and, previous to the construction of the harbour at Ponta Delgada, was sometimes used in bad weather by the mail steamers and other vessels. There is a large village here, with numerous villas and gardens charmingly situated. This bay affords the best landing on the northern coast of the island.

Between the Morro das Capellas and Ribeira Grande, 7½ miles to S.E., the coast is rugged and surf-beaten.* *Fanais Point*, 2½ miles S.E. of the Morro, is a narrow projection of a yellowish colour, and on its East side boats can land at the village of *San Pedro*. *Calheta Point*, 1½ mile farther on, is low and shelving, and at 2 miles beyond this is the bold red headland called *Morro do Rabo do Peixe,* eastward of the large village of that name. At half a mile N.E. by E. from the Morro is a shoal spot of 4 fathoms.

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* Mr. Hunt, formerly English Consul at St. Michael's, makes the following remarks on this coast:—"Persons having stated that the bottom off the North side of St. Michael's is foul in the anchoring depths, and that no vessel would be likely to recover her anchor if she brought up there, I thought it my duty to take the earliest opportunity of proceeding thither, with the agent for Lloyd's at this port, for the purpose of ascertaining the truth of these assertions.

"The result of our survey was, that at about half a mile distant from the shore, between Ribeira Grande and Capellas, there is a line, which, with occasional projections towards the land, separates the foul and stony bottom of the coast from a perfectly smooth and firm bed of fine sand, sloping to seaward; that, along this line, the depth varies from 25 to 35 fathoms; and that, from the rugged nature of the coast itself, the small port or harbour of Capellas is the only part at which it would be safe for boats to disembark."

Ribeira Grande, the town next in importance to Ponta Delgada, contains about 12,000 inhabitants, and the surrounding plains are highly cultivated. Through the town runs a large stream, on which are several water-mills. About 3 miles inland are the *Caldeiras,* or boiling springs, where some baths have been erected, amid charming scenery. The coast here is exposed to winds between N.W. and N.E., which raise a heavy sea, and landing can only be effected when the sea is very smooth. Consequently, its commerce is carried on overland with Ponta Delgada, 9 or 10 miles distant.

In fine weather, vessels may anchor here, and obtain all kinds of provisions and good water. For about half a mile off shore the bottom is rocky; at three-quarters of a mile off the depth is 20 fathoms, but vessels are recommended to lie in 25 to 50 fathoms, bottom of sand. A good position for a sailing vessel is in 35 fathoms, about 1 mile off shore, with the middle of the town bearing about S.S.W., and from hence Ribeirinha Point could be weathered in case of a North or N.W. wind springing up.

Morro Grande is a bold cliffy headland, 2 miles E. by N. of Ribeira Grande, and westward of it is *Ribeirinha Point,* a low sharp projection. At two-thirds of a mile southward of Morro Grande is a small cove, where boats can land. Between Morro Grande and Ajuda Point, 8 miles to E. by S. ½ S., the coast forms an open bay, with low broken cliffs. At 3 miles S.E. of the Morro is *Ponta Formosa,* southward of which is *Porto Formoso,* a cove where boats can land, at a village. Eastward of this many torrents will be seen falling into the sea. At 2 miles beyond Porto Formoso is the village of *Maya,* where boats can also land.

Ajuda Point is low, and around it are some singular basaltic reefs of columnar formation, one rock being in the form of a magnificent arch. About three-quarters of a mile S.W. of the point is the village of Fanaes dos Reis Magos, and near this is a conspicuous convent, 498 ft. above the sea. At half a mile southward of the point is a creek where boats can land.

At 2½ miles S.E. by E. from Ajuda Point is the point and village of *Achada;* midway between is *Achadinha Point.* Hence the cliffy coast trends 4½ miles S.E. by E. ½ E. to *Pedregal Point,* and at 1 mile westward of the latter are the *Peñedos de San Pedro,* some peaked rocks, lying off the village of that name. At 1 mile S.E. by S. of Pedregal Point is *Ribeira Point,* the N.E. point of St. Michael's, and at 1¾ mile S. ½ W. from this is Ponta do Arnel and its lighthouse, before described on page 716. Southward of Ribeira Point are the villages of *Nordeste,* with a remarkable glen through which runs a stream.

Captain Boid, R.N., states that "Nordeste has an exposed rocky anchorage immediately off the town, but offers every accommodation a mile to the S.E., opposite a chapel, in 8 fathoms, with a safe sandy bottom, forming an excellent place of retreat for vessels in southerly or westerly gales. Our flagship ran for shelter to this place, experiencing the transition from a tremendous sea and a furious gale to perfectly unruffled water, with scarcely a breath of wind to bring her to the anchorage."

SANTA MARIA, or St. Mary's, 44 miles S.S.W. from the S.E. end of St. Michael's, is 9¼ miles in length N.W. and S.E., by 4½ miles in greatest breadth, with an area of about 36 square miles. Nearly in the centre is the double-peaked mountain of *Pico Alto* or *Monte Gordo,* 1,870 ft. in height, which falls on the East and West sides to a shelving base of about a mile in breadth, and 850 ft. above the sea. To the North and South it throws out a range of undulating heights, which terminate at the sea in lofty mural cliffs of more than 200 ft. elevation. The East side of this range is covered with hills, diminishing in altitude as they recede from the centre, and intersected by numerous gorges of increasing width and depth, the channels by which the heavy rains of winter reach their points of discharge. The West side is a slightly inclining and undulating plain, also cut by ravines, terminating in cliffs more than 100 ft. high. The aspect of St. Mary's is therefore on all sides perfectly bold; the central peak distinct; the subordinate range high and of varied outline; and the coast abrupt, precipitous, and based by the usual accompaniment of fallen masses.

In its geology, St. Mary's is not like the other islands, where the surface of recent volcanic matter conceals whatever may have been their original constitution, or the progress of their growth. It is of trap formation, and contains, in its beds of marine shells, proofs of its elevation from the sea, but there are some points of similarity in its structure to that of St. Michael's.* Overlaying the rock, in some parts, are beds of clay, used for making pottery, which is exported to the other islands, with lime manufactured from calcareous rock chiefly found on its eastern side. No sign of volcanic action is visible on its surface, but there are evidences of earthquake action.

"On the 31st of December, 1841," says Captain Midgley, "at sunrise, with very clear weather, I made St. Mary's, bearing E.N.E. by compass, distant 45 miles, at which time the land appeared from the deck to be like two small well-defined paps, rising out of the water close together; but on a nearer approach on the same bearing it appeared like a saddle land, which appearance it retained until the summits of some of the lower hills became visible."

The bank of soundings around the island is narrow, the 100-fathoms line passing about 1 mile off the eastern, southern, and western sides, but off the northern coast it extends about 3 miles, with irregular depths.†

St. Mary's contains one town, the Villa do Porto, and several villages, the inhabitants numbering from 7,000 to 8,000, an honest and peaceable people, but very poor. Formerly the island was well wooded and fertile, yielding wheat, maize, and barley, of the first quality, with good wine (resembling that of Madeira), cattle, and horses, but owing to the destruction of the forests* it is now subject to devastating droughts, and the inhabitants are sometimes in great straits. Copious springs of fresh water are found on its northern and eastern sides, but elsewhere it is deficient. Altogether the climate is drier than that of the other islands. It abounds with quail, partridge, rabbits, and rock pigeons.

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* From a description by Mr. Consul C. Hunt, in the "Journal of the Royal Geographical Society," vol. xv., page 260, *et seq.*

† Captain Livingston, in 1818, stated that immense quantities of *mollusca*, or sea-worms, are certain signs of the proximity of St. Mary's. Some of them are white, or the colour of arrow-root mixed with hot water, and are about 18 inches long, with orange spots on them, like the eyes of a peacock's tail. On April 24th, 1890, when off the southern coast of this island, the editor saw some of these creatures.

Villa do Porto, the capital of St. Mary's, is a small town, containing about 2,000 inhabitants, situated on the high land at the head of a small bay, on the South side of the West end of the island. Supplies of fresh provisions may sometimes be obtained here, but water is scarce in dry weather. The bay is three-quarters of a mile in width, between *Marvão* and *Malmerendo Points*, on each of which is an old fort, and within this line it extends 4 cables to the northward to the Castle of Santa Luzia and the landing place. The eastern and western sides of the bay are cliffy, but its northern and eastern sides are fringed with rocks. It has depths of 6 to 12 fathoms in it, foul and rocky bottom, and anchorage is only safe in summer, for small vessels, being completely exposed to southerly winds between S.E. and S.W. San Lourenzo Bay is preferable. The pilots recommend vessels wishing to communicate with the town to lie in 30 to 36 fathoms, sand, with the castle bearing North, open of Marvão Point, 7½ cables to 1 mile off the latter; eastward of this the bottom is rocky.

Prainha Bay is the bight formed between Marvão Point and *Malbusco Point*, 3½ miles to S.E. by E. At 1 mile East of Marvão Point is a black headland named *Figueiral* or *Pedreira Point*, above which rises *Facho Peak*, a remarkable rugged mountain, 758 ft. high. *Pescador Rock*, with 3½ fathoms over it, lies half a mile off shore, at 1½ mile N.W. ½ W. from Malbusco Point; at 1 cable southward of it the depth is 140 fathoms.

Ponta do Castello, the S.E. point of St. Mary's, lies 2½ miles E.S.E. of Malbusco Point, several rocks lying off the coast between. *Sul Rock*, a small round islet, lies 3 cables West of the point, which is high, and surmounted by a peak in the shape of a sentry-box. Vessels have anchored in 8 to 10 fathoms, sand, with the point bearing S.W. by W., distant 5 cables, or less. At two-thirds of a mile N.N.E. of Ponta do Castello is the hamlet of *Maya*, and at 3 cables off the low black rocky point here is *Malha Rock*, only a few feet above water, with a depth of 9 fathoms between it and the shore.

At 1 mile N. by E. ½ E. from Maya Point is *Feiteira Point*, and hence the high cliffy coast trends 2½ miles N. by W. ¾ W. to San Lourenzo Bay. *San Lourenzo* or *Romeira Islet* lies close off the southern point of the bay, with a depth of 5 to 6 fathoms between, and is steep and cliffy, rising to a height of 275 ft.; a detached rock lies 100 yards northward of it, and on its S.E. side is a stalactite cavern, which a boat might enter, above the entrance of which are some curious projecting figures. In old times this islet was a place of pilgrimage.

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* The people say you cannot grow corn and trees too, so the latter are now conspicuous by their absence.

San Lourenzo Bay is three-quarters of a mile in width between the islet and San Lourenzo Point, to N. ½ W., and extends 4 cables westward of this line. The coast is cliffy, with some sandy beaches at the base of the cliffs, the usual landing-place being in a small bight in its northern angle. There are a few houses near the shore, but the village is two-thirds of a mile inland. Good water may be obtained from the streams, or by digging in the sand, and some refreshments may be procured from the village.

The bay has depths of 6 to 11 fathoms, sand, but is exposed to easterly winds, between North and S.E., which send in a heavy sea. A temporary anchorage may be found in 13 to 20 fathoms, sandy bottom, off the centre of the bay; or in 13 to 15 fathoms, with San Lourenzo Point bearing N.W. by N. ½ N., distant about 3 cables, which would be convenient for the landing-place.

From hence to Matos Point, 1¼ mile to North, the coast consists of lofty cliffs with a few off-lying rocks. *Matos Point,* the N.E. point of St. Mary's, is low and rocky, and from hence to *Frades Point,* 4 miles to W. by N. ¾ N., the North coast is indented with several rocky bays, affording neither shelter nor anchorage. At 1¼ mile westward of Matos Point rocks extend half a mile off shore, terminating in *Lagoinhas Islet,* 277 ft. high, shaped like a mitre; its shores are cliffy, but there is a low flat projection from its northern side. At nearly 1 mile N. ½ W. from the islet is a dangerous rocky patch, with only 6 fathoms water over it.

Boats can land in the bay East of *Ribeira Point,* a steep bluff 700 ft. high; also in the western part of the bay West of it, and at the latter may obtain water, also some provisions from the villages of *San Pedro* and *San Antonio.*

Frades Point is 150 ft. high, appears like an island from East or West, and there is landing in the bay eastward of it. From hence to *Cabrestante Point,* 2 miles W. ½ S., the coast is lower, and fronted by a bank of 2 to 4 fathoms, extending 1 to 4 cables off shore. At 1 mile from Frades Point is *Fort Risco,* and native craft anchor off the village here; a breaking rock lies one-third of a mile off shore, bearing N.W. ½ W. from the fort.

Cabrestante Point, the N.W. extreme of St. Mary's, is low and rocky, and at 2½ cables off it is *Maldebarca Rock,* on the edge of the bank. At three-quarters of a mile farther S.W. by S. is *Pendurados Point,* and from hence the cliffy and almost inaccessible coast trends 3 miles South to Malmerendo Point (page 726*)*

Villa Islet, two-thirds of a mile N.W. by W. from Malmerendo Point, is separated from the coast by a narrow channel with 5 fathoms water in it. It is 196 ft. high, with a cliffy coast, and a hillock on its summit.

THE FORMIGAS BANK and **ROCKS** are formed by a submarine mountain of very irregular elevation, and which, traced to the depth of 200 fathoms, was found to extend 6½ miles N. ½ W. and S. ½ E., by about 3 miles in greatest breadth. The bottom is rocky, with patches of sand, shells, and coral. Near the N.W. margin is a narrow cluster of black rocks, known as the Formigas (or *Ants*), extending about 750 yards N.N.E. and S.S.W., by 150 yards in extreme breadth. The southernmost of them, for about 350 yards, forms a closely connected mass, having a small bay on the West. The northern ones are more separated from each other, and all are of comparatively little elevation, but the profile exhibits a few hummocks. That on the southern extremity, which rises 27 ft. above low water springs, is in lat. 37° 16′ 14″ N., long. 24° 47′ W., 20¾ miles N.E. by E. ¾ E. from the N.E. extremity of St. Mary's. No bottom was found at 320 fathoms, midway between.

With smooth water there is no difficulty in landing, particularly on the southern rocks; but in strong winds or a high swell the sea rolls over them all, leaving a black naked surface entirely devoid of vegetation.

The most elevated rock of the group, named *Hormigon* by Tofiño, is 35 ft. in height, and stands on the eastern side, about 160 yards from the northernmost rock; it is somewhat more isolated than the others, and slopes to the southward. Veins of calcareous stone, with fossil shells, are found among these rocks. At 130 yards S.S.W. of the South Formiga is a small rocky shoal patch, visible at low water, the channel between having 5 to 15 fathoms. At nearly 3 cables S.S.W. of the South Formiga is another small rocky patch, having 4 to 5 fathoms on it at low water; it is steep-to on all sides but the North, where it is connected with the rest by irregular depths of 7 to 14 fathoms.

On the North the Formigas may be approached within a few yards, but a narrow ridge runs out 2 cables N.N.W. with varying depths, but no danger; it has 18 fathoms on its outer end, and immediately drops into 30 and 50 fathoms. On the East and West the Formigas are quite clear, with deep water close up to them; on the West the bank extends half a mile, but all very deep water.*

Tofiño thus describes them:—"The Formigas are some rocks which navigators have considered as extremely dangerous, imagining a great part of the space hereabout to be strewed with sunken rocks, and therefore to be avoided; but, having examined these dangers, it is proved that the whole of them are visible, concentrated, and clear, and that vessels of any burthen may steer for them, in order to pass on the North and South side, as may be most convenient."†

At night or in foggy or stormy weather, these rocks are very dangerous, and have been the cause of disastrous wrecks.

Dollabarats Shoal, 3½ miles S.E. by S. ¾ S., from the South Formiga, was shown on a chart of the Atlantic Ocean, dated 1766, but its existence was not confirmed till 1788, when its position was approximately fixed by P. Dollabarats, commander of the French ship *La Marie de Sebourre;* on March 7th, at 3 p.m., he observed the breakers on it, when about to double the Formigas.

Captain Vidal accurately fixed its position, anchoring close to it and scouring the ground with the boats. Within the 5-fathoms line it was found to extend 2½ cables N.E. and S.W., by 1½ cable in greatest breadth. The depths are very irregular, but on its southern part are two or three rocky heads or knolls, which at low water springs have only 11 ft. of water on them. At that time of tide their position is marked by several large white patches, which may be distinctly seen, especially so in bright sunny weather. This is a very insidious danger in smooth water, but in stormy weather the sea breaks over it with great violence.

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* "An Account of the Formigas Bank," by Captain Alex. Vidal, R.N., in the "Journal of the Royal Geographical Society," vol. xix., page 160.

† Tofiño placed these rocks about 3′ eastward of the above position, but Captain A. T. E. Vidal, R.N., who surveyed them in 1843, ascertained their true position by repeated bearings of Punta Castello and Pico Alto, St. Mary's.

The shoal is near the southern edge of a rocky ridge, which extends from it 1¼ mile N.E. ½ N. The soundings over this ridge are most irregular, varying from 14 to 20 fathoms at its edges, but there are no actual dangers on it.

Farther on, and in the Section on Rocks, Shoals, &c., at the end of this work, are some remarks upon other *reported* dangers in this region.

Volcanic Eruptions between St. Michael's and Terceira.—In 1719 and 1720, severe submarine eruptions occurred about midway between St. Michael's and Terceira; the various accounts are conflicting as to the precise position, but it was supposed to occupy the situation of the island which had previously appeared in 1538 and again in 1638. One account states that in 1719 a volcano appeared at 15 leagues to the westward (? N.W.) of St. Michael's, forming an island 10 miles in circumference, which disappeared in 1723. M. Ségur Dupeyron, from documents found in the French colonial archives,* stated that at the end of 1720 a volcano broke out at 28 leagues off St. Michael's towards Terceira, ejecting large quantities of pumice and forming two shoals. A plan of the new island was forwarded to France, though it could not be approached in consequence of the jets of boiling water, which were thrown upwards of 120 ft. high. The French consul announced that, on July 7th, 1722, this island had sunk down, and could only be distinguished by breakers.

A much more complete account was given by Mr. T. Forster, who described the volcano as lying 17 leagues S.E. of Terceira.† He narrates as follows:—"The fire broke out on November 20th, 1720, in the night, and caused an earthquake, which shattered many houses in the town of Angra and places adjacent, to the great terror of the inhabitants. The governor went to the island a month afterwards, and in the afternoon we made an island all fire and smoke; we continued our course till the ashes fell on our deck like hail or snow all night, the smoke and fire roaring like thunder or great guns. Prodigious quantities of pumice-stone, and half-broiled fish, were found floating on the sea for many leagues round the island, which is almost round, and supposed to be about 2 leagues in diameter. By good observation, it is in lat. 38° 29′ N.; long. 26° 33′ W."

In 1848, breakers were reported to have been seen from 7 to 13 miles to the westward of this position. Capt. B. Pratt, of the *William*, and Capt. Victorino Falcao, of the *Tres Amigos*, who both saw it on December 31st, 1848, described the sea as breaking mast high, evidently caused by a shoal and not by any floating object. The observations of the former placed it in lat. 38° 16′ N., long. 26° 41′ W.; those of the latter in 38° 18′ N., 26° 50′ W.*

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* "Comptes Rendus de l'Académie Française," vol. vi., 1838, page 302.

† "Part of a Letter (dated May 12th, 1722) from T. Forster, Esq., F.R.S., to Mr. Machin, Secretary to the Royal Society," in the Philosophical Transactions, 1722, page 100. To this description are attached six views of the island, taken from various points, when 2 to 4 miles distant.

Notice was given, at the same time as the above, that Captain Geo. Perkins, of the *Plymouth*, made the following statement:—"On December 25th, 1848, I saw the sea breaking heavily at the distance of 2½ or 3 miles to N.N.W.; the water broke 60 ft. high in different places, at intervals of about 10 minutes, as if on an extended shoal, having several heads. It was certainly not a floating obstruction; I consider it a narrow reef, about a mile in length, N.N.E. and S.S.W., about 40 miles W.N.W. ½ W. by compass (? true) from the N.W. point of St. Michael's." In any case, the position does not coincide with that of the breakers reported by Captains Pratt and Falcao.

But notwithstanding all this evidence, no indication of any shoal or elevation was found in a subsequent search all over this channel, no bottom being found with from 180 to 350 fathoms of line. This, however, can only prove that there may be no present danger, but it is quite possible that the volcanic action hidden here is at any time capable of raising the bottom to the elevation above described.

In 1894, the authorities at St. Michael's informed us that if these dangers ever existed, they have now completely disappeared.

TERCEIRA, 74 miles N.W. by N. ½ N. from St. Michael's, differs greatly in its appearance, the summits of its mountains composing, for the most part, fertile plains, almost destitute of the cones, craters, and peaks which distinguish the mountains of St. Michael's. This island was discovered April 23rd, 1445, by some Portuguese navigators, and received its name from being the *third* island discovered. In shape it is more compact than any of the other islands, being of an oval form, 16½ miles in extent N.W. and S.E., by an average breadth of 9 miles. The interior is generally mountainous, covered with shrubs, briars, and trees, attaining its greatest elevations in its central and western parts. *Pico Agudo*, 2,650 ft., and *Pico do Norte*, 2,683 ft., are the highest peaks of the central range, which is separated by a deep valley from the *Caldeira de Santa Barbara, da Bagacina,* or *da Serreta,* the rugged mountain occupying the western part of the island. On the latter are several extinct craters, and its two highest peaks are elevated 3,500 and 3,435 feet.

Terceira is entirely volcanic; but the only sign of internal heat now existing is the *Caldeira de Euxofre,* which lies in a deep valley, near the summit of the mountain, about 6 miles N.W. of Angra, and here are some jets of hot sulphurous vapour.† Similar jets and mineral springs are stated to exist in other parts of the island. Earthquake shocks have frequently been experienced, and in 1614 the town of Praya was completely destroyed by an earthquake, which considerably injured the town of Angra, and was severely felt in the island of St. Michael. Since that time it has suffered many other severe shocks of earthquakes.

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* Mr. Walker (see note on page 707) remarks that this shoal appears to have been observed in 1749, but it disappeared shortly afterwards until 1882-3, when it again rose.

† Captain Livingston, in 1822, made the following remarks on this caldeira:—"A great deal of steam issues from crevices of the earth, or rather clay, which clay, I am informed, is actually lava, decomposed by the action of sulphuric acid; it is of various hues, and the natives use it as paint. Small quantities of sulphur are formed around some of the apertures. We cooked some eggs among the clay, at mere cracks whence steam issued. The access to the Caldeira is by no means very difficult; one may ride to within less than half a mile of it, and ponies or asses, and guides, may be readily hired."

In 1841, Praya was again ruined by violent earthquakes, which suddenly commenced on June 12th, and did not cease till the 26th, also causing much damage in other parts of the island. The less severe shocks did not extend beyond the Island of Terceira, others were experienced of apparently equal force at St. George and Graciosa, and only that which destroyed Praya was felt (but not severely) at the capitals of Pico and St. Michael's. At Fayal, and at the eastern end of St. Michael's, no motion was perceived. It is therefore probable that the origin of this earthquake was a submarine volcanic eruption, and that its position or centre was about 17 miles due East from the eastern end of Terceira.*

Another announcement, no doubt connected with the same volcanic centre, appeared in the "Nautical Magazine," July, 1843, page 482, entitled "Malabar Bank," wherein Captain Sartorius writes:—"In lat. 38° 57′ from observations at noon, and long. 26° 5′ by chronometer, and 25° 57′ by reckoning, the ship grazed over, apparently, a shoal of about her own length. There was no sudden shock, no appearance of discoloured water, or any other indication of the vicinity of rocks or shoals; and at the time the motion was felt the ship was going 8 knots, wind aft, and studding-sails set. I immediately shortened sail, and sounded with 180 fathoms; no bottom. There was too much swell to risk a boat for examination. My own individual opinion is, that it is as likely to have been the shock of an earthquake as passing over a shoal."

This spot will be about 35 miles to the eastward of the reported situation of the submarine volcano above described, and if the reader will turn to the description of the Volcanic Region, at the end of this work, he will find that a submarine shock and grounding on a shoal give precisely the same sensation in a ship. That what Captain Sartorius felt was a shock there can be but very little doubt, and it is most probable from the same volcano.

The latest submarine disturbance experienced near Terceira was in 1867, when an eruption occurred at 9½ miles N.W. by N. ¾ N. from Serreta Point. An account of this is given in the "Diario de Lisboa," of July 15th, 1867, for some extracts from which we are indebted to Mr. W. F. Walker, previously mentioned in the note on page 707.

On the evening of June 1st, loud explosions were heard by the inhabitants of Terceira, and the next morning great columns of water and vapour were seen rising from the sea, with repeated detonations. On June 5th, Senhor Nogueira Soares and other officials proceeded from Angra to examine the eruption more closely, and approached within about a mile of it. The surrounding water was discoloured, with dead and dead fish floating about in great numbers, and the air tainted with a strong smell of sulphur. Over a line of more than 2 miles East and West several enormous columns of vapour rose impetuously from the sea, and at the foot of the large black masses were seen rising and falling, with repeated explosions like artillery. On June 8th, these phenomena ceased, and on the 17th, when the locality was again examined in a boat, no vestiges were found of the eruption, the water being of its natural colour, and no bottom was found with the boat's sounding-line.

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* This proposition was ingeniously argued out by Mr. T. C. Hunt, English Consul at St. Michael's, from the various degrees of intensity with which the shocks were felt in the different bearings and distances; by arranging these together, it fixes the centre of the action as above. See "Nautical Magazine," September, 1841, pages 631—633.

Besides Angra the capital, Terceira possesses the town of Praya, and fifteen villages, the population amounting altogether to about 47,000. The island is fertile, pleasant, and healthy, though Captain Livingston stated that dysentery was very frequent, both among strangers and natives, and often fatal.* The soil consists of decomposed lava, yielding large crops of wheat and other grain, and great quantities of oranges, lemons, beans, potatoes, and all those fruits and vegetables of hot and cold climates which are propagated to the best advantage in a temperate climate. The vast lava beds on the North and South slopes of the central range are particularly fertile, and produce excellent wine. There is excellent pasture, supporting fine cattle, and the island abounds with rabbits, quail, woodcock, partridge, and pigeons. Large quantities of pigs and poultry are also raised. Fish is plentiful around the coasts, and springs and streams of good water are found in all parts.

The coasts of Terceira are high and rocky, with few points accessible to an invading enemy; consequently this island has ever been considered as the stronghold of the Azores. The bank of soundings around the island is variable in width, but along its S.W. side the 100-fathoms line is only half a mile off shore; elsewhere it is considerably wider, as shown on the chart.

ANGRA do Heroismo, the capital of Terceira, and the seat of government of the Azores, is picturesquely situated at the head of a small bay on the South side of the island. Its white houses form an amphitheatre rising gradually from the sea, with several handsome churches, conventual buildings, &c., surmounted by the old castle, and encircled by quintas, orange gardens, and vineyards. Its streets are regular and wide, and the houses well built. Provisions and fresh water are abundant and cheap; the boats come out as soon as any vessel is seen approaching, and by them supplies may easily be obtained, even while keeping under way, as they will bring off water, wood, and all kinds of provisions.

Monte do Brasil, to the S.W. of the city, is a volcanic crater, about 2 miles in circumference, rising perpendicularly from the sea, but sloping gently towards the North, the citadel or fort of *San Juan Bautista* occupying the isthmus which connects it with the city. The rim of the crater is of irregular height, forming four peaks, the highest of which, on the eastern side, attains an elevation of 555 ft., and has a watch-tower on it. The interior of the crater forms a large basin, the bottom of which is under cultivation. The eastern shore is fortified, terminating at its eastern point in *Fort San Antonio.*

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* It deserves to be known, that the size of a hazel-nut of Castile soap, scraped fine and dissolved in about three wine-glasses of boiling water, to which add half a wine-glass of good spirits and a few lumps of white sugar, scarcely ever fails of curing bloody flux. Two or three doses may be required. I have tried it on myself and others with great success.—*A. L.*

Light.—Near Fort San Antonio is shown a *fixed bright* light, elevated 80 ft., and visible 8 miles seaward between N. by E. ½ E. and S.W. by S., but it is obscured by Cabras Islets.

Angra Bay is comprised between Fort San Antonio and *Val Point,* 11 cables to East, and extends 7 cables to the N.W., with regular soundings, decreasing gradually from 20 fathoms in the entrance to 4 and 3 fathoms near the city, sandy bottom, with patches of rock; outside, the bottom is foul and rocky. On the point to the S.E. of the city, at half a mile N.E. ½ E. from Fort San Antonio, stands *Fort San Sebastian,* on the western side of which is a little beach, slightly sheltered by a wall of the castle, called *Porto de Pipas,* and here fishing-vessels are secured, by grounding them on the sand. It may serve as a landing-place when the wind will not allow you to land at the mole.*

The bay is open to southerly winds between E.S.E. and S.S.W.; the swell with winds from the S.W., in particular, which sets round Mount Brasil, is tremendous. It is therefore extremely unsafe when winds from those quarters may be expected, the coast being mostly of sharp rocks. Vessels may safely remain here in June, July, August, and September, when the winds are light, and prevail from between West and N.W. But on the commencement of winter, the winds from the offing rage so violently, that, upon the least appearance of bad weather, it is requisite to put off to sea, the coast affording no shelter.

Signals.—When anchorage is dangerous a large red and white pennant is hoisted on the custom-house, and another on San Antonio Point; vessels should then remain outside until the weather moderates.

Ordinary merchant vessels may lie in 11 to 13 fathoms, sand, about midway between Forts San Antonio and San Sebastian, or farther in, in 7 to 9 fathoms, always mooring with two or four anchors. Large vessels anchor outside, in 30 to 40 fathoms, sandy bottom, about half a mile south-eastward of Fort San Antonio, but they must be ready to get under weigh the instant that the wind appears to be coming from the south-eastward or south-westward.

It is high water here, on full and change, at $0^h\ 32^m$; springs rise 4½ feet.

Directions.—The navigation into the bay is easy, and free from danger, but in approaching from the eastward a good look-out must be kept for the dangerous Frayles Rocks; to pass southward of them at night, San Antonio light must not be brought to bear westward of N.W. ½ N. Monte do Brasil forms a good mark, and when bearing N.W. by N. appears in the form of an inverted bowl, with a crooked hummock to the left. In approaching from the S.W., or South, or S.E., steer directly for Monte do Brasil.

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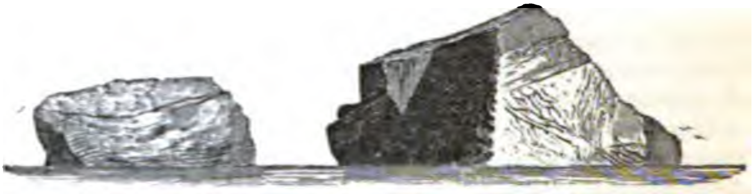
* It is sometimes much easier to land on the rocks under the cliff, on the Mount Brasil side of the bay, than at Porto de Pipas. A footpath, of difficult ascent, marks the proper spot to attempt landing at.—*Captain A. Livingston.*

Should the wind be adverse, when approaching the land, tack boldly without the bay, as there is sufficient depth up to the shore. But beware of a calm, as the currents are very strong and variable. If from the westward, and you have not a leading wind, when sailing up toward the mount, avoid too near an approach to the coast, as it would in a calm be attended with the utmost danger; the coast being ironbound, a ship driven on it would be in a most perilous position.

Cabras or *Goat Islets*, 3¼ miles S.E. by E. from Monte do Brasil, and 6 cables off shore, are two in number, together about half a mile in extent. The eastern islet is the larger and higher, being 480 ft. high, and when seen from the East or West, it appears like a wedge. Between the islets there is a boat channel, with from 7 to 10 fathoms of water; and, in case of need, a vessel may pass between them and the coast, there being 9 to 20, and 26 fathoms of water, with sandy bottom, and rocks near the shore only.



According to Captain Livingston, "some vessels, mistaking Praya for Angra, have stupidly run in there; but the Goats and Mount Brasil are sufficiently to show the most entire stranger the difference. I annex a sketch of the former, taken when about 2 miles distant, the weather being hazy; the point at the left bearing N. by E., by compass, and that at the right hand N.E. ½ N."

The *Frayles* or *Friars*, nearly 2 miles S.E. by S. ¾ S. from the larger Cabra, with of 53 to 69 fathoms between, are two small rugged pyramidal rocks, 30 ft. high, with shoal water close around them, over which the sea breaks. At night, or in thick or heavy weather, a good look-out must be kept for them.

Ponta das Contiendas, the S.E. extremity of Terceira, is 5½ miles S.E. by E. ½ E. from Angra, the coast between being cliffy, with a few villages and projecting points. Contiendas Point is a low projection, backed by three small peaks; boats may land in a cove three-quarters of a mile westward of it, and in another 1½ mile north-eastward of it, known as *Porto Novo*.

The Eastern Coast of Terceira is generally broken, rocky, and dangerous, bordered by rugged precipices of black lava, with no good anchorage for shipping. *Malmerendo Point*, the N.E. point of the island, lies 6 miles N.E. ½ N. from Contiendas Point; it is high, with a rock close off it, dry at low water.

Praya, the town next in importance to Angra, is situated in the most fertile part of the island, on which account it was first selected by the discoverers as their residence; but it has experienced many disastrous earthquake shocks, as previously narrated. It contains about 3,000 inhabitants, and is picturesquely situated in the northern angle of a sandy bay, with rugged rocks on either side, and its shores are defended by several batteries. It is not very healthy, owing to the low swampy land in the vicinity. Supplies of provisions and water can be obtained here, as at Angra, and coal may sometimes be procured.

Praya Bay is 1¼ mile in width between Malmerendo Point on the North, and Santa Catharina Point on the South, with depths of 6 to 12 fathoms, sandy bottom, but being completely exposed to all winds to the eastward of North and South, is consequently very unsafe in the bad weather months. The depth shoals regularly towards the shore, the 3-fathoms line being found at less than 2 cables off the town, and at 3 cables off the S.W. angle; boats should not attempt to land at the latter part.

The safest anchorage is outside the bay, in 19 to 25 fathoms, sand, about 1 mile off shore, with the West end of Carneiros Islet touching Malmerendo Point, N. ¼ W., and the two steeples in the town, or the two towers at the bottom of the bay, in line. In the fine season, June to September, vessels may anchor farther in, in 7 to 16 fathoms, S.E. of the town. The fishing boats lie sheltered by a sandy tongue, on which stands *Fort Porto,* opposite the northern end of the town.

The high peaks of Agudo and Norte form good marks for this bay, which is free from hidden dangers, but in heavy weather the sea breaks for some distance on the rocky ledge extending off *Baxios Point,* southward of the bay.

Between Malmerendo Point and *Espartal Point,* 4 miles N. by W. ¾ W., the coast consists of high inaccessible cliffs. At 1¼ mile S.E. by E. from Espartal Point is *Carneiros Islet,* 62 ft. high, lying half a mile off shore.

The North Coast of Terceira should not be approached by a stranger, as it is rocky and dangerous. *Villa Nova Rocks,* 1 mile N.W. ¼ W. from Espartal Point, are low, and lie nearly half a mile off shore. In the small bight to the S.W. of them is the large village of *Villa Nova,* where boats can land. At 7 miles N.W. by W. ¼ W. from Espartal Point is *Rua Longa Point,* and a large village, with rocks extending some distance off it, in a bight, westward of which boats may land. At 1¼ mile westward of this is the *Pico de Pinto,* 502 ft. high, the northern part of which has been carried away by the sea.

Serreta Point, 4¼ miles West of the Pico de Pinto, is a projecting cliffy headland, forming the N.W. extremity of Terceira, with a bight on either side. At 1¾ mile N.W. ¾ N. from it is the southern of *Serreta Rocks,* two rocky patches of 4¾ fathoms, together extending three-quarters of a mile North and South, by half a mile in width. The soundings close around these dangerous rocks vary irregularly from 10 to 55 fathoms, and unless the sea breaks over them, there is nothing to indicate their position.

The S.W. Coast of Terceira is rocky and inaccessible, there being only one landing place between Serreta Point and San Matheo Point, at about 2¾ miles N.W. by N. from the latter. Between San Matheo Point and Monte do Brasil, 2 miles to the S.E., the coast is low and forms an exposed bay, only frequented by native craft. The land here is fertile and more thickly populated. The telegraph cable is landed about half a mile north-westward of the Monte do Brasil.

GRACIOSA, 30 miles N.W. by N. from Terceira, is 6⅜ miles long N.N.W. and S.S.E., by 3⅜ miles in greatest width. It is very hilly, its highest part being the *Pico de Pedro Botelho* range, elevated 1,378 ft.; this is separated by a deep valley from the *Caldeira*, at its S.E. end, elevated 1,349 feet. The N.W. part is not so high, but has several peaks, so that when seen from a distance to the N.E. or S.W., it presents the appearance of two or three islands. Near its S.E. point are some hot springs. The population amounts to about 8,000, peaceable and industrious, distributed among the towns of Santa Cruz and Praya, and several villages.

Graciosa is said to have received its name in consequence of its superior beauty to the other islands when viewed from the sea. These, on account of their rugged cliffy coasts, present rather an uninviting appearance from a distance; but the shores of Graciosa, on the contrary, are nearly all low, and rise gradually inland, thus showing the rich undulations and plains between them and the mountains. It is also considered to be the most fertile island of the group, yielding great quantities of barley, wheat, maize, wine, aguardente, and all kinds of fruit and vegetables. Cattle, sheep, pigs, and fowls are plentiful, the only scarce article being wood, which is obtained from San Jorge and Pico. It is said that bricks form the principal export.

The bank of soundings around the island is somewhat irregular in shape, the 100-fathoms limit varying from half a mile to 3½ miles distant, bottom of sand, coral, or rock. There are several small islets and numerous rocks lying close around it.

Carapacho Point, the S.W. extremity of Graciosa, is a low rocky projection, with rocks around it, one with 7 ft. water over it lying 3 cables to S.W. ¼ S.; within it the land is high and rugged. At one-third of a mile S.E. by S. from the point is *Baxo Islet*, 450 yards long, with a conical peak at its N.W. end, but low to the S.E.; a rock, like a broken column, lies off its N.E. side, and a rocky ledge projects around the S.E. end, terminating to the S.E. in a small rock. Vessels passing between this islet and the coast, where they will find depths of 10 to 18 fathoms, must pass close to the islet to avoid the rocks off the coast.

Between Carapacho Point and *Ponta dos Fanaes*, 1½ mile to N. by E. ½ E., the coast is almost uniform and clear, consisting of cliffs rising above a narrow beach; two low rocks lie close off Fanaes Point.

Praya Bay is a slight rocky indentation to the N.N.W. of Fanaes Point, and here is the town of *Praya*, the only landing being in a small sandy bight in front of it. The telegraph cable from San Jorge is landed here. *Ponta Negra*, northward of the town, is low and rocky, and at 5½ cables E.S.E. of it is *Praya Islet*, which appears like a wedge from the N.N.W. or S.S.E., sloping from N.E. to S.W. It is surrounded by rocks, and at 2½ cables E.S.E. from its South extreme is a patch of 4 ft. water, with 6 to 14 fathoms around it; another patch, of 6 ft., lies 1⅓ cable North of the N.E. extreme. Depths of 7 to 11 fathoms are found in the channel between the islet and the coast.

Vessels usually anchor about 3½ cables south-westward of the islet, in 10 to 12 fathoms, off the town, but they are exposed to all winds between West and South, round by North and East.

From Negra Point the coast trends 2¼ miles N. ¾ W. to *Ferreira Point*, which is very low, with a dangerous reef reaching 2 cables northward and eastward of it. There is a rocky bight on either side of the point, and in that to the N.W. is the town of Santa Cruz.

Santa Cruz, the capital of Graciosa, is of considerable size, and of some commercial importance, containing about 3,000 inhabitants. The coast is low, and the land rocky, with scattered fragments of rock about it. Close to the town, on the S.W. side, are three small hills near each other, with a church on the highest part of each of them, forming good marks for the North side of the island.

Light.—On *Fort do Santo*, at the North end of the town, is shown a *fixed bright* light, elevated 49 ft., and visible 8 miles.

There is no anchorage close to the town. The best anchorage around Graciosa will be found in from 30 to 40 fathoms, sand, off the southern extremity of a great slope of land extending towards Ferreira Point, with Baxo Islet in line with, or rather a little open of, the western part of Praya Islet. Here vessels may put to sea with any wind, but they lie sheltered only from South, by the West, nearly to North. This is the anchorage for vessels communicating with Santa Cruz.

Pico Negro Point, the North point of Graciosa, is 1¾ mile N.W. ½ W. from Santa Cruz, the coast between being fringed with rocks. This point is high and very black, with some large rocks off it, and the coast hence continues high and rocky for 2 miles S.W. by W. ½ W., to *Fozo do Porto Point*, and is all lined by a rocky shoal. Close S.W. of this point is another, the small bight between being full of rocks.

Gomez Bay, 3 cables southward of Fozo do Porto, is one quarter of a mile in width, with cliffy shores, and 3 to 4 fathoms water in it. *Gomez Point*, its southern point, is low, at the base of *Monte Vermelho*, 516 ft. high. Vessels can anchor about 1 mile off this bight, in 15 fathoms, coral bottom. Boats can land near Gomez Point, to the N.E. of which is the village of *Victoria*.

At 2 miles S. ½ E. from Gomez Point is *Frades Point*, very high, with a stone on its summit resembling a man, and between this and *Branca Point*, a very high and sloping point 1 mile farther on, are the highest cliffs of Graciosa. Less than 1 mile inland is *Mount Pedro Botelho*, 1,378 feet high, the highest peak of the island. At 2 miles S.E. of Branca Point is *Fogo Point*, low and rocky, the coast between forming a bight. At half a mile N.N.W. of Fogo Point is *Forte Islet*, near which there is good landing.

At 1¼ mile S.E. by E. from Fogo Point is *Sul Point*, whence the rocky coast continues 1 mile E. by S. to Carapacho Point, at half a mile westward of which are some hot springs.

SAN JORGE, or St. George, 19½ miles to the S.W. of Graciosa, is 28½ miles long, N.W. ½ N. and S.E. ½ S., but its average width is only 2½ to 3 miles. Its central part is occupied by a mountain range, sloping rapidly on either side, its highest peaks attaining elevations of 3,498 and 3,463 ft., the former named *Pico da Esperança*. Separated from this range by a deep valley to the S.E. is a high plateau, the summit being *Cabeza de*

Patalogos, 3,122 ft., and the land then slopes gradually to the S.E. point, with several peaks on it. The narrow N.W. part of the island is occupied by a ridge, the highest peak of which is *Monte do Trigo*, 1,685 feet.

San Jorge contains about 18,000 inhabitants, occupying three towns and seven villages, Vellas being the capital. It is noted for its cattle and cheese, and wine of good quality is made and exported. The land is fertile, and yields the same productions as the other islands, its yams being the best of all. Wood and fresh water are abundant.

Its coasts are cliffy, with rocks close-to, and the bank of soundings is narrow, so that sailing vessels should not attempt to use the channel between San Jorge and Pico, unless in settled weather, or with a steady breeze, for a sudden calm may prove fatal, as a strong current runs through the channel, according to the state of the tide, and it is difficult for a vessel drifting on to either coast to anchor in time to avoid shipwreck.

San Jorge has experienced some fearful volcanic disturbances, especially in 1580, 1691, 1720, 1757, the last and most destructive being in 1808. On May 1st, 1808, a dreadful volcano, seen from Fayal, burst out about the centre of the island, in the midst of fertile pastures, about 9 miles S.E. of Vellas. On the 3rd a crater was formed, throwing out cinders, or small pumice-stones, which covered the earth from 1 to 4 ft. in depth, and then, passing the channel, did some injury to the eastern end of Pico. The fire of this large crater nearly subsided on May 3rd; but in the preceding evening another small crater had opened, 3 miles to the northward of the large one, and only 6 miles from Vellas. The eruption lasted about 25 days, and the island, heretofore rich in cattle, corn, and wine, was nearly ruined; and a scene of greater desolation and distress has seldom been witnessed in any country.

Ponta do Topo, the easternmost point of San Jorge, lies 25 miles W. by N. from the summit of Monte do Brasil, in Terceira. It is of moderate height, with rocks around it, extending to *Topo Islet*, 60 ft. high, and flat, which lies about 2 cables East of the point, and is likewise surrounded by rocks. At half a mile S.W. of Topo Point is *Pontinha Point*, on the West side of which boats can land in a small cove at the village of *Topo*.

The N.E. Coast is formed of high cliffs, and trends in almost a straight line with but few slight indentations, and is almost inaccessible; the only landing place is close to the S.E. of *Norte Grande Point*, 15½ miles N.W. ¾ N. from Topo Point. This coast is much less populous than the S.W. coast. A reef extends 2½ cables off Norte Grande Point, and above it rises the *Pico da Esperança*, the highest peak of the island. At 6½ miles S.E. ¾ S. from Norte Grande is *Caldeira Point*, and here a shoal extends more than one-third of a mile off shore; the telegraph cable from Graciosa is landed S.E. of it. *Gonzalvo Point* is 8½ miles N.W. of Norte Grande, and at 4¼ miles farther on is Rosales Point, towards which the cliffs gradually become lower.

Rosales Point, the N.W. extremity of San Jorge, 21½ miles S.W. by S. from Gomez Point, Graciosa, is a narrow sharp projection of moderate height, with a rocky ledge extending one-third of a mile off it, on which stand two remarkable pinnacle rocks, 234 and 232 ft. high, one called the *Padre* resembling a kneeling priest. Vessels are recommended to give this point a berth of 1 mile, not approaching it within the depth of 25 fathoms.

The S.W. Coast is cliffy, and in sailing along it an almost continuous line of dwellings will be seen. From Ponta de Rosales the cliffy coast trends 6¼ miles S. by E. ¾ E. to the *Morro Grande*, a high hill of a blackish colour, with a vigia, or look-out, on its summit. On the North side of the Morro is a rocky bight, wherein several vessels have been lost, by mistaking it for the Port of Vellas, the bottom being all rocky, and a sailing vessel, once in, cannot leave it without a change of wind.

Porto das Vellas.—At 1½ mile S.E. ½ S. from the outer point of the Morro Grande is *Queimada Point*, rather low, with a small fort on it. Between the two points is the Bay or Port of Vellas, sheltered from winds from N.W., by the North, to S.E., and here the telegraph cable is landed. On the northern shore of the bay is the town of *Vellas*, the capital of the island, and on the S.E. side of this is a small mole, having 3 fathoms within it, but with rocky bottom. The regular anchorage is to the South of the mole, in 9 fathoms, fine black sand, about midway between the points. Vessels moor with two anchors to the N.W. and S.E., and from this position can put to sea, should an on-shore wind set in. Vellas contains about 3,000 inhabitants, but is of little commercial importance. Native craft find shelter behind the mole. It is high water here, on full and change, at 0^h 30^m; springs rise 4 to 5 feet.

Light.—At the head of Vellas Bay is shown a *fixed bright* light, elevated 62 ft., and visible 8 miles.

From Queimada Point the coast continues low and rocky to *Monteiro Point*, 18½ miles to S.E. ½ S.; this is a high sloping point, whence the cliffy coast trends 3 miles E. by S. ½ S. to Pontinha Point, before described. Boats can land eastward of *Castellitos Point*, 4 miles from Queimada Point, and at *Calheta*, 5½ miles farther on, whence wood is shipped to the neighbouring islands. At 1½ mile farther on is *Forcada Point*, eastward of which boats can land, and also at *Faja de San João*, 5½ miles beyond.

PICO, to the S.W. of San Jorge, is separated from it by a deep channel, 10 to 12½ miles in width. This island, taking its name from the remarkable mountain upon it, is 24½ miles in length N.W. ¼ W. and S.E. ¼ E., 8½ miles in width at the N.W. part, but narrowing off to 2½ miles at its S.E. end. All the island is mountainous, with several peaks over 2,000 ft. in its S.E. part, the highest being *Pico do Topo*, 5,357 ft., 9 miles from the S.E. point. Dominating all is *O Pico* (*the* peak), occupying a great part of the N.W. end of the island, its summit soaring to a height of 7,613 ft. above the sea, and visible 75 miles or more* in clear weather, but it is frequently obscured by clouds. The mountain itself is of a conical form up to the edges of the crater; this is about 500 ft. in diameter and 70 ft. deep, the lips sloping to the S.E., and on the N.E. side rises a volcanic cone, 300 ft. high, still giving vent to puffs of hot vapour, and so very regular in shape that one would think it had been made by art. It is also stated that at the foot of the mountain, toward the East, is a spring of fresh water, generally cold, but sometimes so heated with subterraneous fire as to rush forth in torrents, in a boiling state, and sending forth a stream of sulphurous vapour, vitrified stone, &c. Snow lies on the upper part for about 8 months in the year. The base and lower half of the peak is covered with vines, gardens, and orange groves, above which is a region of shrubs and pasture, succeeded by bare black rock with patches of verdure.

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* It is said to have been discerned at a distance of 110 miles. In summer the ascent can be made in about 9 hours, and 8 hours will suffice for coming down.

Dr. Bullar remarks:—Few objects can be altogether more interesting or beautiful than this mountain, whether arrayed in the riches of its summer garb, or enveloped in the austerity of wintry gloom. From afar off it appears like an isolated cone, tipped on the apex with that apparently superposed sugarloaf peak, which renders Pico so recognisable at the first glance. Its peak answers the purpose of a never-failing barometer. On the approach of bad weather a fleecy cloud (the "Cap") forms and hangs a little below the summit, a sure indication of change and unsettled weather; this cloud will increase in proportion to the coming storms, until it entirely obscures more or less of the upper part of the mountain. In the absence of this "cap," fine settled weather may always be calculated on with certainty.

The population of Pico numbers about 24,000, a robust and peaceable people, occupying three towns and eleven villages, mostly engaged in cultivating the vine, which flourishes amid the black lava, and yields wine reputed to be the best in the Azores; this, with brandy, is exported in considerable quantities. Excellent cattle find grazing in the upper parts, and fruit and vegetables are abundant and good, but, the soil being rocky, little grain is produced, and the greater part of the wheat and maize for local consumption is imported from the other islands. The climate is healthy, drier and more bracing than the neighbouring islands. The island once abounded with fine timber, including cedar and a beautiful kind of yew called *teixo*, now nearly all destroyed.

Dr. Bullar remarks:—"This island is more obviously and strikingly volcanic than any other in the group which we have visited. It may almost be likened to a sifted heap of cinders, the large ones having rolled down to make the rough and craggy coast at its base." Only three or four eruptions have been recorded since the island was inhabited, one on the North coast in 1572, and the others on the South in 1718 and 1720.

Captain Boid remarks:—"The whole coast of Pico is bordered by rugged unapproachable rocks, without a port or anchorage for a ship." The bank of soundings around it is very narrow, 100-fathoms being found at less than 2 cables off shore in some parts. The coast mainly consists of low cliffs, above which are seen long rows of dwellings.

Ponta da Ilha, the S.E. point of Pico, 11¾ miles W. by S. from Monteiro Point, San Jorge, is rather low and sloping, with a rocky ledge extending 1 cable eastward of it. Boats can land at *Calhao Grande*, S.W. of it, or in two small bights between this and *Calheta* or *Nesquin Point*, 2½ miles W. by N. of Ponta da Ilha; these are known as the ***Muelle de Manana*** and *Nesquin*, fit only for coasters, which may ground on the sand, the bottom being generally rocky. At 7 miles W. by N. ½ N. from Calheta Point is the *Ponta de Arrife*, which is rather more elevated; the coast between continues rocky, and is not to be approached by strangers. On Arrife Point is a small cone, and to the north-eastward are the three hills named *Cabeza de Granga*, 1,461 ft. high, above which *Pico do Topo* rises to an elevation of 5,357 feet. At 1 mile N.W. ¾ W. from Arrife Point is *Castello Point*, and between this and Santa Catarina Point, 2¾ miles to N.W. ¾ N., is *Lages Bay*, rocky, with no anchorage.

Lages, the capital of Pico, is situated on the low rocky S.E. shore of the bay. This coast is broken and fronted by rocks and islets, and one of the indentations forms a kind of lagoon, the bar of which can be crossed by boats at high water, and here the island craft lie sheltered from the sea. *Puerto Praima*, N.E. of *Santa Catarina Point*, also affords shelter to boats. Above this point is the crater, which was in eruption in 1720.

At 6 miles N.W. by W. ¼ W. from Santa Catarina Point is San Mattheus Point, and midway between is *San João Point*, above which rise two craters, the northern one active in 1718. *San Mattheus Point* is a low promontory, above which rise five hillocks, backed by O Pico, and to the N.W. is the town of *San Mattheus*. At 3⅜ miles N.W. ¾ N. of this point is *Espartel Point*, within which is the village of *Candelaria*, with two towers close together. At 2¾ miles North of Espartel Point is *Pé do Monte Point*, at one-third of a mile within which is the *Monte*, 437 ft. high.

The West Coast of Pico, forming the eastern side of Fayal Channel, consists of low rocky cliffs, with a few indentations, and all fringed with rocks. At 2½ miles N.E. ¾ N. from Pé do Monte Point is the town of *Magdalena*, whence the greater part of the produce of the island, for exportation, is shipped off for Fayal in small row-boats.

Magdalena Rocks.—A rocky shoal of 2½ to 3 fathoms extends 8½ cables N.W. by W. ½ W. from Magdalena, and on its outer extremity are two large red rocks, the southern one 1½ cable long and nearly flat, with an arch through its western part, and the northern one appears like a great ruinous tower 237 ft. high. Depths of 7 to 12 fathoms are found close westward of these rocks, but vessels should not approach them within 20 fathoms. The telegraph cable from Fayal passes S.W. of these rocks, and is landed southward of Magdalena.

At 1½ mile E.N.E. of Magdalena is *Baixo Grande Point*, off which extends a rocky ledge, and in blowing weather breakers reach off this part of the coast for a mile or more.

The N.E. Coast of Pico needs but little description, beyond what the chart shows. It consists of low and rugged cliffs, rather more elevated towards the S.E. end, with no anchorage, and almost inaccessible. It is well populated, and boats can land at *Porto Caxorro;* on the North side of *San Antonio Point;* at *Caes do Pico;* and at *San Roque*. The telegraph cables from San Jorge and Terceira are landed at *Prainha*.

FAYAL CHANNEL, between Pico and Fayal, is 3¼ miles in width in its narrowest part, between Arealarga and Espalamaca Points, but the clear channel is reduced to 2⅝ miles by Magdalena Rocks. The soundings are irregular, varying from 54 fathoms and under in the N.E. part, to 139 fathoms and under in the S.W. part. Nearly in the middle of the S.W. entrance of the channel is *Chapman Rock*, a dangerous rocky patch with 4 fathoms least water over it, not more than 50 yards in extent N.E. and S.W., by 20 yards in breadth, with 20 to 50 fathoms at 1 cable around it, so that the lead forms no guide. From it, the Collegio and Carmelitas Convent at Horta are in line about N.N.W.; Espalamaca Point Signal Station bears N. ¼ E., distant 2⅛ miles; Guia Chapel, N.W. ⅛ N., 1¾ mile; the Monte, S.E. ½ E., 2⅜ miles; and the high Magdalena Rock, N.E. ¾ E., 2¼ miles. In heavy weather, the sea breaks over it to such a degree that it sometimes bears the appearance of a waterspout.

In running for Fayal Channel, the peak of Pico should not be depended on as a guide, as it is sometimes enveloped in clouds for five or six days in succession. In working through, a vessel should not approach the land too closely, to avoid squalls and shifts of wind, and must beware of Chapman Rock. Espalamaca and João Diaz Points in line, N.N.E., lead half a mile West of this danger; and the South extreme of Guia Head, in line with the S.W. extreme of Fayal, N.W. by W. ½ W., leads one-third of a mile northward of it. The flood stream runs to the N.E. through this channel, and the ebb S.W., attaining a rate of 1 to 2 knots an hour.

FAYAL takes its name from the *faya*, a species of large myrtle, which was found in abundance when the island was first colonised. It is 11 miles in extent, N.W. and S.E., and 7 miles across in its widest part, rising with gradual undulations towards the *Caldeira* or crater in the centre, on the southern edge of which is *Pico Gordo* or *Grande*, 3,351 ft. high; this crater is 1 mile in diameter, and 1,800 ft. deep, partly occupied by a lake. Several volcanic eruptions have occurred since the island was inhabited. That of 1672, when the Caldeira was active, destroyed several villages, and laid Horta under a sheet of ashes. In 1862, numerous earthquake shocks were felt, and vessels at sea reported submarine disturbances near the island. Earthquakes of some violence are still occasionally experienced.

Fayal is less rocky, and contains in proportion more land fit for cultivation, than the other islands, and has always been noted for its excellent pastures, wheat, maize, vegetables, fruit, wood, &c., but it produces no great quantity of wine. The air is always mild and pure; the cold of winter is never felt, and the heat of summer always tempered by refreshing winds. The population numbers about 25,000, occupying nine villages and one city, Horta being the capital.

The coast of Fayal is not so cliffy as some of the other islands, and there are but few dangers around it, the bank of soundings being narrow.

Monte da Guia, or *Guia Head*, the southern extremity of Fayal, is a curious volcanic peninsula, very similar to the Monte do Brazil in Terceira, but nearly all under cultivation. It is about half a mile in diameter, attaining an elevation of 487 ft. in its western part, where there is a chapel, or *ermida*, and a *Signal Station*. It slopes down on its northern side to a low and narrow isthmus, at the northern end of which rises the black *Monte Queimada* ("burnt"), 268 ft. high, with some buildings on it.

Pim Bay, between the N.W. side of Guia Peninsula and the rock-lined shore opposite, is a small bight open to the S.W., but used by small craft in fine weather. The depth shoals gradually from 8 fathoms at the entrance to 3 and 2 fathoms in its inner part, which is known as *Porto Pim*, and here is a sandy beach. There is anchorage in 17 to 19 fathoms, sand, about one-third of a mile N.W. by W. from the West point of Guia Peninsula.

Caldeira Inferno appears to be the crater of Guia Peninsula, now being an inlet extending 2½ cables northward from its southern side. In the outer part there are depths of 8 to 13 fathoms, but a 3-fathoms patch lies nearly midway between Caldeira Point and the three rocks on the East side of the entrance. Half-way in, the depth decreases to 2 fathoms, and then increases to 4 and 5 fathoms.

Espalamaca Point, nearly 2 miles N.E. ½ E. from the South point of Guia Peninsula, is a perpendicular cliff, on the summit of which is a *Signal Station*, elevated 420 feet. Shoal water extends around the point, a depth of 2 fathoms being found at 1½ cable off.

HORTA BAY is comprised between Guia Peninsula and Espalamaca Point, extending 7 cables N.W. of this line, the depth decreasing from 20 fathoms towards the shore, bottom of sand, gravel, and shells. For 1 mile north-eastward of Monte Queimada, a black sandy beach fronts the city of Horta; then follows the *Ribeira dos Flamengos*, a small stream, eastward of which the coast is cliffy to Espalamaca Point. The telegraph cables from St. Michael's and Pico are landed near this stream. This bay forms one of the best anchorages among the Azores, and a breakwater is being constructed to form a harbour.

Horta, containing about 7,000 inhabitants, has a pleasant appearance from seaward, consisting of a long line of white houses along the shore, backed by others on the rising ground, amid gardens and trees, and behind all rise the hills and peaks on the slopes of the Caldeira. At its southern end is the *Castello de Santa Cruz*, and here is the landing place; northward of this is the *San Francisco Convent*, beyond which is the *Collegio*, with two central towers, and on the higher land within is the *Carmelitas Convent*, a very similar building. Supplies of all kinds are good, and moderate in price, but fresh water is stated to be brackish and scarce, being obtained from wells close to the sea. Coal is stored for the use of steamers, and is sent off in lighters. Only slight repairs to iron vessels and their machinery can be effected here; a slip is under construction. There is telegraphic communication with Lisbon and the intermediate islands. A public hospital is maintained here.

The Breakwater is a substantial work, extending over the rocks in a N.E. direction from the eastern side of the Guia isthmus. When completed it will be about 1,300 yards in length, and will shelter a considerable area, with depths of 10 fathoms and under. It was commenced in 1876, and in 1893 about 1,000 yards had been completed, but less than one-half of this can be considered as effective, the remainder being the embankment of land reclaimed, which will be available for quays by dredging. The part above water terminates in about 10 fathoms, but large quantities of stone have been deposited beyond this, so that vessels must exercise caution in approaching.

Lights.—A *red* lantern light, visible 7 miles, is usually shown on the extremity of the works above water, and the extremity of the sunken part is marked by a *bell buoy*, on which a *red* light is placed when the weather permits, and vessels must not attempt to pass between. At night, if these lights are not seen, do not approach within 20 fathoms without the aid of a pilot.

Fayal Bay is open to winds between N.E. and S.W. round by East and South, though Pico gives some shelter from the sea between E.S.E. and S.S.E. In winter the wind occasionally blows hard between S.E. and S.W., when it would be advisable for a sailing vessel to weigh and run to leeward till the weather moderates, though with good ground tackle she might ride securely, the holding ground being good. At the present time the breakwater is not sufficiently advanced to shelter more than three or four vessels of moderate size.* It is high water, on full and change, at $11^h 45^m$; springs rise 4 feet.

In winter, therefore, sailing vessels anchoring here should always be prepared for a start on a shift of wind. The safest method is to let go the anchor in 35 or 40 fathoms, bottom of sand, about 1¼ mile from the town, which will be with João Diaz Point bearing N.N.E., a little open to the right of Espalamaca Point, and the Collegio in the city, about N.W., a little open to the southward of the Carmelite Convent. From this spot a ship may depart with any wind.

In the summer season and favourable weather, the general anchorage is with the two buildings in the town as above described, but nearer to the town, in 25 fathoms, sandy bottom; small vessels and steamers proceed farther in, to 20 and 15 fathoms.

Directions.—To sail in, if from the northward, no directions are requisite, as the way is perfectly clear. If coming from the S.W., with a free wind, the usual passage is between Chapman Rock and Monte da Guia; or, if more agreeable, between the same rock and Pico, according to circumstances. With the wind from the West or N.W., take especial care to avoid this dangerous rock, by observing the marks for it, on page 742.

If, on approaching the road from the S.W., the wind should be dying away from the eastward, and you intend to tack, so as to gain the anchorage, keep over toward Pico, within the distance of 1 or 1½ mile; because at a little farther out the bottom is rocky, and you cannot anchor, in case of necessity; besides, by proceeding thus, you will be free from variable eddy winds and calms, which are caused by the mountains; and the coast is sufficiently clear.

Praya Bay is the bight between Espalamaca Point and João Diaz Point, 1½ mile to N.N.E. In its southern part, at the foot of the Pico

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* Lloyd's Agent at Fayal, in a communication dated August 28th, 1893, states as follows:—"A great hurricane swept over this island to-day, between 8 and 10 a.m., and the only two vessels moored at the breakwater, the American barquentine *Tremont*, and the Italian barque *Giuseppe Emanuele*, were driven ashore, and both went to pieces in less than an hour."

dos Frades 704 ft. high, is the village of *Praya*, near the mouth of a small river, on the North side of which boats may land on the beach. Trading-vessels at Port Magdalena, on the opposite side of the channel, when assailed by violent winds from the southward, frequently bear up, and find good shelter here, anchoring off the village in 17 fathoms, sand and shells over rock, with Espalamaca Point and Guia chapel in one.

João Diaz Point is low, black, and rocky, with a small beach where boats can land. Between it and Ribeirinha Point, nearly 1½ mile to N.E. by N., the coast consists of red sloping cliffs, very high to the South. *Ribeirinha Point* slopes down to high steep cliffs, with some detached rocks around. On its South side is a narrow beach, at the mouth of a stream. If necessary, vessels can anchor in 20 to 25 fathoms, three-quarters of a mile S. ½ W. from the point. From Ribeirinha Point the cliffy coast trends 6 miles N.W. by N. to *Cedros Point*, the northern extremity of Fayal, and a long line of cottages will be seen all along. About midway between is *Salão Point*, near which boats can land.

From Cedros Point, which is high and abrupt, the cliffy coast trends 1 mile W. ½ S. to *Jorge Lourenzo Point*, above which rises a conical hill 470 ft. high. Hence it trends 2 miles farther W.S.W. to the village of *Praya do Norte*, where there is a small sandy beach, and the cliffs then continue for 3 miles W. by N. ¾ N. to *Negra Point*, with several off-lying rocks. Here the coast turns to S.W. by S., and at three-quarters of a mile distant is *Comprida Point*, low and sloping, the western extremity of Fayal; boats can land on its southern side. It has been proposed to build a *lighthouse* here.

Capellinha Rocks are the outermost of the dangers lying off the coast between Negra and Comprida Points. In fine weather boats can pass between them and the coast. At 3 miles S.E. by S. from Comprida Point is *Varador Point*, with the long village of *Capellas* between. At half a mile E.S.E. of Varador Point is a small bight where boats can land near the village of *Ribeira do Cabo*. To the northward is seen the *Pico do Fogo*, which was in eruption in 1672. Thence the cliffy coast extends to Castello Branco Point.

Castello Branco Point is a small hill, surmounted by a fort, and connected with the land by a low narrow isthmus, so that at a distance it appears like an island. The coast hereabout is rocky, and affords no anchorage. A long line of dwellings is seen extending all along to Horta. At 1½ mile S.E. ¾ E. from Castello Branco Point is *Forte Point*, where boats can land. Between this and Pim Bay, 4 miles to E.S.E., the coast is low and rocky, with a few off-lying rocks. About midway between is the cove and village of *Feteiras*, westward of which are two large rocks.

FLORES, 118 miles N.W. ½ N. from Fayal, and the westernmost island of the Azores, is 9¼ miles long N. ½ E. and S. ½ W., and 6¾ miles across where widest. The name is said to have been given to the island by its first colonists, owing to the beauty of its trees and shrubs, and the profusion of its flowers and herbs. The coast is everywhere bold and rocky, and rises steeply towards the mountains, *Morro Grande*, its highest peak, attaining an elevation of 3,087 feet. In its southern part are several peaks between 2,100 and 2,500 ft. in height. The hill tops abound in excellent pasture, trees and shrubs, while the slopes yield luxuriant crops of wheat, barley, beans, yams, potatos, &c., but fruit is not plentiful. The moss called orchilla, used for a dye, is here found in abundance, clinging to the rocks and declivities. Cattle, small but good, sheep, pigs, goats, and poultry, are raised in large quantities and exported. Woodcock abounds, with wild duck and snipe. There is abundance of fresh water, falling in numerous cascades from the heights. Like Corvo, no volcanic eruptions or earthquakes have been experienced since its colonisation, about the year 1460, though there are one or two sulphurous springs.

Flores contains about 10,000 inhabitants, and the men are noted as good sailors. Santa Cruz is the chief town; Largens comes next in importance; and besides these there are four villages.

Owing to the facilities for obtaining water and provisions of various kinds, in fine weather, this island was formerly much resorted to by whalers and homeward-bound sailing vessels, and even at the present time, it is important to know that such useful refreshments can here be so readily procured; a tedious homeward passage may make this place of the greatest benefit.

The Climate of Flores and Corvo is healthy and delightful, being much drier than that of the islands previously described, but violent storms and sudden squalls are experienced in their vicinity at all seasons. Captain Boid says that the changes from the extreme of fine to that of foul weather are rapid beyond conception, requiring the constant vigilance of the navigator. These atmospheric transitions are sometimes induced by the approach of immense icebergs, drifted hither by the Gulf Stream.

The bank of soundings around Flores varies from 1¼ to 4 miles in width, to the 100-fathoms line, affording good anchorage almost on every side. The anchoring ground is generally beyond the distance of a mile from land; within that distance the ground is rocky, and much farther out it is the same.

Flores and Corvo form a separate group from the rest of the Azores, and the intervening channel, 118 miles wide, has no known danger, and therefore is probably the best to use in passing through the archipelago.* The current sometimes sets to the N.E. through this channel, with varying strength according to the wind; but, as a general rule, the continuation of the drift from the Gulf Stream bears to the S.E. and South, rarely to the S.S.W. This is more usual to the North of the islands.

Ponta Delgada, the North point of Flores, is of moderate height, surmounted by a small conical hill; it is surrounded by rocks and small islets, steep-to, which extend one-third of a mile to the N.E. Southward of the point is a village, also fronted by rocks. *Ponta Ruiva* (red), 2¼ miles S.E. ¾ S. from Ponta Delgada, is 735 ft. high, steep and rugged; the coast between consists of low cliffs, and forms a bay which affords anchorage in 20 to 25 fathoms, sandy ground, half a mile off shore, sheltered from winds from S.E., round by South, to W.N.W. It is frequently resorted to for water, or by vessels compelled by the wind to quit the eastern side of the island. *Pan de Azucar* or *Bottle Rock*, 100 ft. high, lies off Ponta Ruiva, and a fishing boat may pass between.

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* On December 18th, 1884, when about midway between Fayal and Flores, the barque *Isabel* experienced a terrific earthquake, accompanied by appalling submarine thunderous roarings, in lat. 38° 51′ N., long. 29° 55′ W. This is very close to the position of a white patch and breakers seen in 1863, by Capt. Gicquau of the French ship *Mayotte et Nossibé*, in lat. 38° 42′ N., long. 29° 43′ 54″ W.

From Ponta Ruiva the rocky coast trends 3⅓ miles S. ¼ E. to Ponta Santa Cruz. At 1 mile from Ruiva is *Alvaro Rodriguez Islet*, very near the coast; and to the S.E. of this there is anchorage in 25 to 36 fathoms, sandy bottom, sheltered from the West and S.W. Santa Cruz Point is low and rocky, and the coast hereabout is all fronted by dry rocks.

Santa Cruz, the chief town of Flores, stands on a flat tongue of land, backed by lofty hills, and contains about 3,000 inhabitants. It is well built, the most conspicuous buildings being the lofty and spacious church, and the old Franciscan monastery. Supplies of cattle, sheep, pigs, fowls, vegetables, firewood, &c., can be obtained here at moderate prices, and fresh water is abundant. There is regular communication by mail steamer once a month. Behind the town *Monte da Cruz* rises to a height of 704 feet. Vessels rarely attempt to anchor off the town, the usual anchorage being in the bay to the southward. The landing places are approached by narrow passages between the low off-lying rocks.

At 1¾ mile S.W. of Santa Cruz is *Ponta Cabeira*, low and rocky, rising with a gentle acclivity. Between these points the coast forms a bay, with a beach and a small river at its head, the best anchoring place about the island, and sheltered from all points between North, by the West, and S.W.; the proper depths are in from 19 to 40 fathoms, sandy ground. This is the nearest anchorage to Santa Cruz, and therefore the most frequented. Boats can land on the South side of Ponta Cabeira.

At 1 mile S.W. ½ W. from Ponta Cabeira is that of *Lomba*, which is high and steep; between these points the coast forms a bay, with a beach and small river at its northern end. A vessel may anchor in this bay, in 22 to 25 fathoms, sandy bottom, but it is not so well sheltered as that to the northward, being open to easterly and southerly winds. Above Lomba Point is the conspicuous church of Boa Vista, and hence the high cliffy coast trends 2 miles S.W. ¾ W. to Largens Point.

Largens Point, the S.E. extreme of Flores, is high and steep, with a ridge of rocks extending about 2 cables off it. Within it is the town of *Largens*, with its conspicuous church, a useful landmark for this part of the coast, and the landing place is on the North side of the point, near the mouth of a stream. Vessels may anchor eastward of Largens, in depths of 17 to 25 fathoms, sandy ground, with winds between North and S.W. by W., round by West. This anchorage is much frequented, because a sailing vessel can here get under way more easily than at Santa Cruz, having better room for working out.

Escolar Rock, with 4½ fathoms over it, and 30 to 50 fathoms close around, is a dangerous patch about 1½ cable in diameter, of a whitish colour. It lies about 1 mile off shore, at 1½ mile W. by S. ½ S. from Largens Point, and must be carefully avoided; it breaks in heavy weather. At 3 miles W. by N. ½ N. from this, and 1⅓ mile S.W. ½ S. from Ilheos Point, is *Laranjeira Rock*, with 11 fathoms over it.

From Largens Point the high rugged coast trends nearly in a straight line, 3¾ miles N.W. by W. ¾ W., to Ilheos Point. Between Largens and Roca Alta Point the cliffs gradually increase in height, and at 1¼ mile from Largens is *Lope Vas Point*, low by the sea, but high and steep within. *Roca Alta Point*, 1¼ mile farther on, is a perpendicular high brown cliff, above which rise three jagged rocky peaks, the highest elevated 2,108 feet. Between this and Ilheos Point a rocky shoal extends 3 cables off shore, with 5 to 11 fathoms close-to.

Ilheos Point, the S.W. extreme of Flores, is low and rocky, and off it lie several small islets. Here is a spring of hot mineral water. There is anchorage in 23 fathoms, sand, about three-quarters of a mile W.N.W. of Ilheos Point. At 1½ mile to N. ½ E. is *Cantarinhas Point*, off which lies a remarkable islet, and the coast between consists of broken cliffs. Between Cantarinhas Point and Bredos Point, 1¾ mile to N. by E. ¾ E., the coast forms a bight, into which run three large streams; vessels here find good anchorage in 20 to 25 fathoms, sand, about half a mile off shore, with Cantarinhas Islet bearing S. ¾ W.

Bredos Point is high, steep, and of a whitish colour, with some large rocks off it, one on its southern side resembling a column. South of the point is a sandy beach, and at 1½ mile inland *Pico Caboco* rises to a height of 2,466 feet. Northward of this the land is lower near the sea, but inland is a continuous range of stupendous variegated precipices or cliffs, at the base of Morro Grande.

Between Bredos Point and Baxio Point, 1¾ mile to N. by E. ¾ E., the rocky coast is lined with a sandy beach, off which vessels may anchor in 25 to 30 fathoms, sand, sheltered from N.N.E., through East, to S.S.E. At half a mile from Bredos Point is the mouth of a large stream, and inland will be seen the village of *Fajem Grande*, backed by the southern part of the range of inland cliffs. Within Baxio Point is the village of *Fajemzinha*, and the conspicuous church of San Pedro, situated amid the grandest scenery, perhaps, to be found among the Azores; a small inlet runs up to it from the North side of the point.

Fanaes Point, 2 miles N.E. ½ N. from Baxio Point, is low, with high land close behind it, and off it lie some rocks. The coast between forms *San Pedro Bay*, off which vessels can anchor in 25 to 30 fathoms, sand, and in fine weather fresh water may here be readily obtained from a cascade, by means of a hose, so as to fill the casks without taking them out of the boat.

Monchique Islet, 110 ft. high, lies 1 mile N.W. by W. from Fanaes Point, and is steep-to. At half a mile S.E. by S. from it, with deep water between, is *Baxio Rasa Islet*, nearly connected with the shore by a rocky ledge. To the S.E. of this islet is the best landing on the N.W. side of Flores, and here supplies of cattle, sheep, pigs, poultry, eggs, and vegetables, may be readily obtained at moderate rates, provided the weather be fine and the wind between N.E. and S.S.E., round by East. The best place to land is southward of a beach of large black boulders (where the landing is dangerous), passing between the rocks. Here water may be obtained from a fountain about half a mile inland, and the people will willingly assist in carrying it down in small casks. With any other wind, particularly if blowing hard, there would be too much surf, and the passage too narrow to enter safely.

In leaving Fanaes, sailing vessels are advised to run off due West for 2 or 3 miles, to get clear of the high land to the North of the landing-place, by which they would avoid being becalmed under this land when the wind is from N.E. to S.E., and would be enabled to run clear of the island.

Between Fanaes Point and Albernas Point, 2 miles to N.E. ¾ E., the coast consists of high cliffs, and about midway between is *Gadella* or *Maria Gadella Islet*, 520 ft. high. There is anchorage West of this islet, in 30 to 40 fathoms, sand or gravel.

Albernas Point, the N.W. extreme of Flores, is 270 ft. high, steep, and of a reddish colour, with rocks around it. Hence the cliffy coast trends 1¼ mile E. by S. to Ponta Delgada, before described, and between them is the mouth of a large stream.

CORVO, the northernmost and smallest island of the Azores, received its name (signifying *crow*) either from its sombre dark blue appearance when first descried, or from the flocks of crows seen on it by the discoverers. It lies 9½ miles N.E. ¼ E. from Flores, the channel between being deep and clear, and consists of a single volcanic mountain, 3½ miles long, N.N.E. and S.S.W., and 2½ miles in greatest width, or 9 miles in circuit. The extinct crater, called the *Caldeira*, occupies all the N.W. part of it, and is 3½ miles in circumference, the highest part of the ridge surrounding it being on the S.W. side, where it is 2,548 ft. in height. The East and West margins are lower, in some places not exceeding 1,434 ft., but the northern edge rises to a height of 2,199 ft., so that when seen from N.E. or S.W. the summit has the appearance of a saddle. At the bottom of the crater are several hillocks, and two small lakes, the surface of which is 1,277 ft. above the sea and 1,271 ft. below the highest part. Its population numbers about 1,000, a contented and industrious people, chiefly engaged in rearing small cattle, sheep, pigs, goats, and fowls, and growing maize, wheat, beans, potatos, flax, &c.; orchilla is found growing on the rocks. *Rosario*, the village, is situated near its southern point; whalers and other vessels occasionally call here for provisions, and the mail steamer visits it regularly once a month. Landing, however, is sometimes impossible for weeks together, and in the winter of 1860 the tremendous seas completely cut off all communication for five whole months.

In clear weather, Corvo can be seen 55 miles from the deck, but the summit, even in summer, is so frequently capped with clouds, that rills of water are seen running down the mountain in the month of August. Its shores are bold and cliffy, and the bank of soundings is generally steep, and very abrupt on its outer edge, the 100-fathoms line varying from half a mile off the southern end, to 1¼ mile off its North and N.W. sides, and to less than 1 mile off its eastern side. Along the N.W. side the bank is comparatively shallow and rocky, to the extent of half a mile from the land, where there is 15 fathoms. To the eastward the bottom is generally of sand, sometimes with coral, and rocky patches. To the West the prevalent bottom is also sand, with some gravel and rocks. A vessel should not drop anchor till she is assured beforehand of the quality of the ground and depth of the water, which increases regularly from the shore to 50 or 60 fathoms, and then suddenly falls to above 200 fathoms. There is good anchorage on either side of the low tongue of land forming the S.W. end of the island. Captain Vidal, however, could not advise the adoption of these anchorages, nor of any others the island may afford, except as a matter of necessity. It has no fuel to spare, no facility for watering, nor, indeed, anything to offer which cannot be most abundantly and conveniently obtained at Flores; whilst, from its size and form, it affords little shelter from wind and sea.

It is high water at Flores and Corvo, on full and change, at $12^h 20^m$; springs rise about 3½ feet. The flood tide sets upon Corvo N. by E., and the ebb in the opposite direction, with an ordinary velocity, at springs, of 1½ mile an hour. When this is opposed by a gale it occasions a very high, confused sea, as it sweeps over the rocky uneven bottom around the North and South points.

Pesqueiro Point, the S.W. extreme of Corvo, is low and rocky, but sharp and well defined; rocks extend nearly 2 cables off it, and front the coast round to the village. About midway between the point and village is the mouth of a small stream, where there is good landing. Two dangerous detached rocky shoals lie 2½ cables off the South point; one, with 4½ fathoms over it, lies to S.S.W., and the other, of 3 fathoms, to S.E. ¾ E., with the church bearing N. by W. ½ W., distant 3 cables. They are both steep-to.

Rosario stands on rising ground on the East side of the South point, and contains 160 or 170 thatched stone houses. At the South end of the village stands the church, a small stone building with a square tower and short spire, which, being kept well whitewashed, is a good sea-mark. About 250 yards S.W. by W. from it there is a little rocky hill, surmounted by an antique horizontal windmill. Facing the village is a small stony beach, where a few fishing-boats are hauled up, but the surf which usually plays upon it makes the cove to the westward of the mill a preferable landing-place.

The anchorage off Rosario is sheltered only from north-westerly winds, and should be approached by bringing the church to bear about W.N.W., and let go in from 16 to 9 fathoms, from one-half to one-third of a mile off shore. In approaching from the S.W., give the off-lying shoals a wide berth.

Between Rosario and Casa Point, 1½ mile to E. by N., the coast consists of high cliffs, within which are seen several deep ravines. On *Casa Point* is a conical hillock, and off it lie two low rocks, one 1 cable to S.E. ½ E., the other 2½ cables to N.E. by E. ½ E., and the sea breaks violently on them. Hence to the northward the cliffs increase in height, and at 2 miles N.N.E. from Casa Point is *Ponta de Nordeste* or *Moira*, a bold bluff 760 ft. high; at 3 cables N.E. by E. from it is a dangerous rock with only 3 ft. water over it, and steep-to, which only breaks in blowing weather.

Ponta de Norte lies 1½ mile N.W. ½ N. from Nordeste Point, the coast between presenting a series of high inaccessible cliffs, fronted as before by a narrow belt of stones. From the top of the cliffs the land rises with great abruptness to the margin of the Caldeira, a height of 2,200 ft., where the horizontal distance from the sea does not exceed 2,000 feet. Ponta de Norte is 368 ft. high, jutting out 150 yards from the coast, inaccessible from the sea, and, when seen from East or West, shows an overhanging face to the northward; its extremity is in lat. 39° 43′ 30″ N., long. 31° 7′ 20″ E. Between this and Turrais Point, 4 cables West, the cliffs are fronted by rocks, one high and black.

Ponta de Turrais, the N.W. point of Corvo, is very remarkable; it runs directly down from the North edge of the crater into the sea, a sharp, serrated ridge of dark lava.* At 1½ cable North of it, with Ponta de Norte bearing E.N.E., there is a sunken rock, on which the sea breaks violently, and in rounding it, it will be advisable not to approach this point in less than 20 fathoms.

Ponta de Oeste, the western point of Corvo, lies 1¼ mile S.W. ½ S. from Turrais Point, the coast between being partly a steep declivity, covered with shrubs and wild vegetation, followed by a range of lofty cliffs, fronted by rocks. Ponta de Oeste descends in terraces to the sea, and about one-third of a mile S.W. by S. from it is a small, low, detached rock, named *Ilheo de Mulher*, 50 yards off the beach. From this the cliffy coast runs due South, 1 mile, to *Sugarloaf Rock*, 148 ft. high, a mass of lava standing at the base of a bold, cliffy point. Hence to the southward the coast consists of a ragged outline of steep cliffs, and then a low coast of very broken outline, fringed by numerous rocks, trends S.W. by W. to Pesqueiro Point. This portion of the coast is fronted by innumerable rocks, projecting from the shore in narrow ridges of broken lava to an average distance of 200 yards. In strong winds the sea rolls over them in enormous breakers, but the danger is not so wide as it appears to be.

Between Mulher Islet and Pesqueiro Point the coast forms a bight, where vessels may anchor in 15 to 25 fathoms, sand, from one-third to three-quarters of a mile West of Sugarloaf Rock, or farther off in 30 to 35 fathoms, protected from winds between North and S.E. Boats can land at a small sandy beach.

REPORTED DANGERS around the Azores.—From time to time circumstantial announcements have been made of rocks and reefs lying around and far away from the islands, many of which have since been sought for unsuccessfully. Still, it is advisable to exercise caution, considering the volcanic nature of this region, where islands have been forced up from great depths, and afterwards disappeared, as narrated in previous pages. The following are the reports most worthy of notice.

KUTUSOFF OR ST. MARY BANK.—In 1816, the officers of the Russian vessels *Kutusoff* and *Suwaroff*, sailing in company, when in about lat. 35° N., long. 28° W., observed ripples and a change of colour in the water. They took several casts of the lead, finding bottom at 110 to 127 fathoms, over an extent of about 10 miles

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* When seen from the N.E. or S.W., the rocks on this ridge assume very curious forms, and may have given rise to the tradition, that when this island was discovered, a colossal equestrian statue was seen on this point, with the right arm outstretched towards the West; this was said to have led to the discovery of the New World by Christopher Columbus.

East and West, and thought there were rocks awash on its eastern part, though no breakers were seen.

Captain Andrew Livingston, whose statements are always reliable, also reported a bank in this vicinity. He says:—"On our passage, in 1819, from Havana to Barcelona, we passed over white water, apparently a shoal, to the south-westward of St. Mary's. The captain would not allow the vessel to heave-to in order to sound; but I have no doubt in my mind of its being a very extensive bank of soundings. I should not be surprised if it turned out that the bank we passed over was connected with the Kutusoff Bank, which lies about 1 degree to the S.W. of the one we passed over. We were some hours crossing the bank." Capt. Livingston considered its position was lat. 35° 58′ N., long. 27° 19′ W., from satisfactory observations. Nothing more is known about it.

Tulloch Rocks were originally reported by Captain William Tulloch, of the brig *Equator*, in 1808, and since that date others are stated to have seen them, though they have been searched for in vain by surveying vessels. The accounts given are so circumstantial and corroborative, that they lead to the conclusion these rocks may have been volcanic in their origin, and afterwards disappeared.

Captain Tulloch, when his crew gave the alarm of breakers, found he could not weather them, and, as a last resource, passed through them. From aloft he counted distinctly twenty-one heads of rocks, none of which appeared to have much water over them, and two of them showed occasionally above water in the wash of the sea. Their extent, the captain thought, did not exceed half a mile North and South, and was still less East and West. They bore E.N.E., by compass, from the highest rock of the Formigas, then in sight, distant about 10 miles, and appeared very black below water.

Mr. Ferguson, mate of the ship *Ayrshire*, gave their situation as about 9 miles E.N.E., by compass, from the Formigas. Captain J. Henderson, ship *Fortesque*, stated that he saw Tulloch Rocks, April 17th, 1829, when breakers were observed for half a mile East and West. The greater Formiga and breakers in one bore W.S.W., by compass, the former about 12 miles, and the latter 6 miles distant.

However, this reef was not found by Captain Wilkes, U.S.N., in 1838; and Captain Vidal, R.N., sought minutely for it. The steamer steered E.N.E. from the Formigas, for 14¼ miles, sounding, at frequent intervals, with a line of 200 fathoms, without reaching the bottom, and returned, traversing *across* this bearing. On three subsequent trials, no signs of shoal water or soundings were obtained. Captain Vidal remarks that "seeing the difficulty there is in discovering small rocks beneath the surface of the ocean, we by no means presume to assert that Tulloch Reef does *not* exist, but we entertain a very decided opinion that it will not be found in the position which has been assigned to it."

Volcanic Disturbances between St. Michael's and Terceira.—Allusion has been already made to these on pages 729—730.

Keus or Europa Rock.—Captain D. Keus, of the Dutch ship *Europa*, reported that at day-break, December 10th, 1853, he passed about 2 miles from a "*black mass*," appearing like a rock or reef, 15 or 20 ft. high, and about 200 ells in length, in lat. 38° 15′ N., long. 22° 14′ W. This would be about 130 miles eastward of St. Michael's, but its existence is very doubtful.

Whale Rock is another doubtful danger, which has been sought for in vain. In 1800, Capt. Gradun, of the *Harmony*, saw high breakers in lat. 38° 46′ N., long. 24° 47′ W., nearly the position given by M. Fleurieu, at about 37 miles northward of the East end of St. Michael's.

On November 25th, 1857, Captain W. Cook, of the *Estremadura*, bound for Fayal, when in lat. 39° 57′ N., long. 25° 50′ W., saw abaft the beam what was thought to be a squall, but which turned out to be a kind of mist or warm steam, which lasted half an hour; the wind was N.E. The waves then changed to a kind of boiling, or topping sea, as if surged up from below, but it returned to its former state, when the mist was passed. This position would be about 87 miles to N. by W. of the given position of Whale Rock, and 93 miles N.E. by E. ¼ E. from Terceira.

GOUGH OR HARRISON ROCKS.—In the chart by M. Rochette, 1778, dangers were shown in lat. 40° 28′ N., long. 30° W. (about 90 miles north-eastward of Corvo), with the words "Rocks seen by Captains Gough and Birch." Van Keulen and Bellin also indicated several dangers in the vicinity to the N.E., but their existence has been denied by the pilots of the Azores.

Captain Livingston says:—"Captain Beaufort, of the brig *Concord*, told me at Malaga, in 1820, that he twice saw Gough and Birch Rocks, when bound from Newfoundland to Lisbon; that one of them is about 12 ft., and the other 3 ft. above water; and that they lie nearly in the longitude originally assigned them, but 5′ more to the northward."

Another report states that Gough Rocks were seen by Captain Harrison, in the brig *Hope*, April 17th, 1830, in lat. 40° 16′ N., long. 33° W. At 11 a.m. two rocks appeared close under the lee-quarter; in smooth water these rocks would be even with the surface, and in the hollow of the sea Captain Harrison could distinctly see them 6 or 8 feet down in the water.

Mr. Keen, of Liverpool, forwarded to us the account of their having been sighted by Capt. Robertson, of the *Hugh Black*, in 1862, making it 10 miles farther North than the position first assigned, or lat. 40° 38′ N., long. 30° 2′ 45″ W., the latter determined the day after sighting Flores. He says it would not be seen in smooth water, but with a low swell, it showed a surface of about 10 ft. covered with long rock-weed.

Mr. E. S. Roberts, of London, also kindly forwarded to us, in 1874, the following extract from a letter he received from Captain Hugh MacNulty:—"In 1854, I was in command and part owner of the ship *Frederick*, from Calcutta for Liverpool. In October of that year I was North of Corvo, one of the Azores; the breeze moderate from E.N.E. I tacked ship to the S.E., and afterwards saw Gough Rocks, and passed within a cable's length of them, in lat. 40° 30′ N., and long. 31° 10′ W., approximately. They are flat rocks, about 250 ft. long and 250 ft. broad, and 2 ft. above water; they lie about 1 mile apart E.S.E. and W.N.W., true. I find that they are left out of the new Admiralty Charts. They are very dangerous, being so far from land, and so much in the way of shipping."

Notwithstanding the non-verification of these reports by the sounding lead, which ought to invalidate them, and from the circumstance of the Azores pilots not knowing of them, there appears to be some reason for retaining them. The bottom is not so deep here as elsewhere, for 330 fathoms only was found by the U.S. vessel *Dolphin*, 20 miles to the North of Gough's, or 10 miles to the North of Captain Robertson's position.

Volcanic Disturbance, &c., between Fayal and Flores.—Particulars are given in the note on page 746.

FERREIRA AND CONSTANTE REEFS.—In October, 1840, the Lisbon authorities announced that:—"Manoel Mariano Ferreira, pilot, while navigating from Paraiba to Lisbon, on board the Brazilian brig *Constante*, at 10 a.m., August 26th, 1840, saw breakers at 1 or 2 miles to windward. The vessel remained in the same position for six hours; at noon, it being then high water, the surf had nearly disappeared; at 2 p.m. it again became perceptible; and at 6 p.m. a group of rocks was clearly visible above the water. By the latitude observed at noon, and the longitude by a good chronometer, the rock being about 1¼ mile distant, I compute their situation to be lat. 37° 56′ 20″ N., long. 33° 4′ 8″ W.

"On August 31st I passed near another rock, which is marked in the chart as having been seen by Captain Robson (about 75 miles westward of Fayal). At 8 a.m. I saw some rocks above water, over which the sea broke, and which I passed to leeward at the distance of 1 to 2 miles, in lat. 38° 26′ 44″ N., long. 30° 25′ 10″ W." The first of these reefs was named *Constante Reef*, and the second *Ferreira Reef*.

Near to the asserted position of Constante Reef, Captain J. Keyzer, of the Dutch ship *Buto*, on May 5th, 1845, saw a white patch about 130 ft. in diameter, in lat. 37° 42′ N., long. 32° 57′ W. The sea was smooth at the time.

In Bellin's chart of 1742 a *vigia* is marked in lat. 37° 50′ N., long. 34° 18′ W., originally copied from Van Keulen, and named *Martyr Shoal*, or *Vigia dos Azores*. This is about 60 miles westward of Constante Reef.

Against the authenticity of these reports we have the authority of Captain T. D. Sickens, of the Dutch Marine, who passed over the area with a good look-out from the rigging, without seeing anything, and then steered N.W. by N. over Constante Reef, &c., with the same result.

Again, a *volcanic shock* was felt March 13th, 1853, in lat. 38° 9′ N., long. 31° 55′ W. Near to this, however, a depth of 2,000 fathoms has been found.

At all events much circumspection is necessary in sailing through these parts.

RHOON OR PRONK ROCKS.—Captain A. Pronk, of the Dutch bark *De Hoop*, stated that on the afternoon of April 6th, 1844, the vessel passed within a cable's length of an extensive group of rocks, some more than 16 ft. high, against which the sea broke furiously. By very good observations and a trustworthy chronometer, this danger was placed in lat. 38° 32′ N., long. 33° 16′ W., which would be about 40 miles northward of Constante Reef.

ATILA ROCK.—The captain of the Spanish brigantine *Atila* reported that in May, 1856, he and his crew saw a rock in lat. 36° 31′ N., long. 32° 24′ W., or about 200 miles W.S.W. of Fayal. The weather prevented an examination, but its existence is extremely doubtful.

We have thus enumerated the above reports, more as a matter of interest, than from belief in the existence of these dangers. And we can only here again express our regret, that originators of such reports should take so little pains to verify them by close investigation.

4.—THE ISLANDS OF MADEIRA, PORTO SANTO, AND THE DESERTAS, ETC.

PORTO SANTO lies 435 miles W. by S. ¼ S. from Cape St. Vincent, and 345 miles N.W. by W. from Mogador, the nearest part of the African coast. It was discovered in 1418 by João Gonsalvez Zarco and Tristam Vaz, dependents of the famous Portuguese Prince Henry. They had set out to explore the African coast, but when off Cape St. Vincent their vessel was overtaken by a storm, by which they were driven off the coast to this island, where they found shelter, and named it, in consequence, Porto Santo.

This island was for some time the place of residence of Christopher Columbus, he having married the daughter of Bartholomeu Perestrello, the first governor of the island. The widow of the latter, having noticed the interest Columbus took in nautical matters, gave him Perestrello's instruments, charts, &c. From these, and other circumstances, he conceived the existence of land to the West, which led him back to Europe, to prepare for and undertake his successful voyage of discovery, which was in the year 1492.

The island is 6⅝ miles long, E.N.E. and W.S.W., from 1½ to 2½ miles in breadth, and about 17 miles in circuit. In fine weather its high land may be seen when 50 to 60 miles distant, first appearing as two or three hummocks, by which it is distinguished from Madeira and the Desertas. The N.E. part consists of numerous rocky pointed mountains, some nearly 1,700 ft. in height, and all its North coast is generally composed of high inaccessible cliffs, with detached rocks at their bases. The central part is much lower than the extremities, but the cliffs on the North and N.W. coasts rise to 700 ft.; from whence it slopes to the S.W., and terminates in a beautiful white sandy beach, which forms its entire S.E. shore. On the central part are several sandy plains, covered with what appear to be fossil heath-stems, but probably of coral formation. The S.W. end of the island is also rocky and elevated, some of the hills exceeding 900 ft. in height, one peak, that of *Anna Ferreira,* having a summit like a column. The structure is volcanic, with deposits of coral limestone on Baixo Island, which is quarried and exported to Madeira. There are also reported to be deposits of manganese on Porto Santo.

Porto Santo contains about 1,750 inhabitants, nearly all resident in the town of Villa Baleira, and under administration from Madeira. The island is chiefly used for pasture, but cultivation extends along the shore of the bay and the low land, producing grain, vegetables, and inferior wine; also plenty of live stock and poultry. In 1892, the vintage amounted to over 1,000 pipes. The island suffers grievously for want of water, which is only found near the town, and there are few trees on the island, firewood being obtained from Madeira.

Porto Santo stands on an extensive bank of soundings, on which are several off-lying islets and rocks. The banks abound with fish.

Villa Baleira, the town, is situated near the centre of the bay on the S.E. side, about 300 yards from the beach. The church and court-house are conspicuous; and a little to the West of them is a small battery, in lat. 33° 3′ 30″ N., long. 16° 20′ W. Several windmills will be seen around, and at 1¼ mile N. by E. ¾ E. from the church is the *Pico de Castello*, 1,447 ft. high, and on its summit are the ruins of several water tanks and stone buildings. The two peaks immediately to the East are *Facho* and *Gandaya*, the highest in the island, the former being 1,660 ft. high.

Porto Santo Bay, comprised between Baixo and Cima Islets, is the only anchorage, and affords fair shelter in the settled weather during summer, but sailing vessels must take care not to become embayed here in a southerly gale, as it is then dangerous. A good berth is in 17 fathoms, gravel and broken shells, 1 mile off the beach, with the church bearing N.W. by N. ½ N., and the South point of Cima Islet, E. ½ S., and from hence to the southward the depth rapidly increases to 100 fathoms at half a mile distant. A convenient berth is farther in, in 12 fathoms, 6 cables off the beach, with the Pico de Castello bearing N. ¼ W., and the South point of Cima E. by S. ½ S. The landing at Porto Santo is usually made upon the beach in front of the town, though there are no artificial facilities for so doing. It is high water, on full and change, at $12^h\ 50^m$; springs rise 7 feet. There is but little inducement for vessels to call here.

Ponta de Incão, the eastern point of the bay, is composed of high rocky cliffs, and at 2 cables S.S.E. of it is *Cima Islet*, the channel between being obstructed by rocks, among which there are passages for boats. Cima is flat, and at its S.E. end rises to a height of 361 feet. It is steep-to, and off its southern end is a good fishing ground. *Ponta dos Frades*, 1 mile N.E. by N. from Incão Point, is a bold steep projection, and the bay between is known as *Porto dos Frades*. At 1½ cable off Frades Point is *Peñedo Redondo*, a rock a few feet above water, and hereabout the 100-fathoms line is from a half to three-quarters of a mile off shore.

Ponta Branca, the N.E. point of the island, is composed of three bluffs, the northern one of which forms a fine, bold promontory, the peak of which is 1,390 ft. high. At 1 mile southward of the point is a sandy beach with a stream, at the head of a small bight.

Off Ponta Branca lie three cliffy islets, steep-to, with navigable channels between. *Pescador*, the innermost, lies 3 cables E. by N. from the point; it is 358 ft. high, and covered with brushwood. *Lourenzo Rock*, 6 cables N.N.E. from Pescador, is composed of a cluster of rocks, the highest 38 ft. high, with a few bushes on them. The outer or *N.E. Rock*, 6 cables N.N.E. from Lourenzo, is 330 ft. high, and covered with bushes. These islets lie on a rocky bank extending 3¾ miles off the N.N.E. side of Porto Santo, and on it, at 1¼ mile N. by W. of N.E. Rock, is a patch of 10 fathoms, where the sea breaks in bad weather.

Santa Cruz Point, 1½ mile N.W. ¾ W. from Ponta Branca, is sharp, with a rock a few feet high lying 1 cable off it. Hence the coast trends 3½ miles W. by S. ½ S., and then 2¼ miles S.W. to Furado Point, all high and rocky. The bank of soundings extends 8 miles North of this coast, with general depths of 25 to 35 fathoms, bottom of fine white sand, rock, gravel, shells, and coral. *Fonte Rock* is of black basalt, 270 ft. high, and lies 1 mile off shore, at 2½ miles W. by N. ½ N. from Santa Cruz Point.

Falcon Rock, lying near the N.E. edge of the bank of soundings, is very dangerous, being a mere knoll, on which there is 4½ fathoms at low water, and breaking in bad weather. It lies on a rocky bank of 11 to 17 fathoms, 3 cables in extent, and from it N.E. Rock bears S.E. ½ S., distant 6½ miles; Fonte Rock, S. ½ W., 4½ miles; and Ferro Island, S.W. by S. ¾ S., 8½ miles. The extreme eastern high land of Porto Santo bearing S.S.W., leads well East of it; the extreme western high land bearing S. ½ E., leads West of it; and vessels coming from the N.E., with a fair wind, may pass between the rock and Porto Santo, by keeping Fonte Rock in line with the high land at the S.W. end of the island, bearing S.W. by S.*

Styx Bank, 9 cables N. by W. ¾ W. from Falcon Rock, is a rocky area with 12 fathoms least water, and 17 to 20 fathoms near it. At one-third of a mile East of it the depth is 100 fathoms.

Furado Point, the western extremity of Porto Santo, is a double point, lower than the adjacent cliffs, which are 900 ft. high, and from hence they gradually decrease in height to *Calheta Point,* the western extremity of Porto Santo Bay.

Ferro Islet, lying about 1¾ cable off Furado Point, with a deep channel between, is of triangular form, 380 ft. high, with an almost inaccessible cliffy coast.

Baixo Island lies 2 cables off Calheta Point, the channel between being only fit for boats. This island is nearly 1½ mile long, N.N.E. and S.S.W., with a cliffy coast, rising at its northern end to an elevation of 570 feet. On the West side of the northern end is a cove, where the limestone, with which the island abounds, is shipped in boats for Madeira.

Fora Islet, with its lighthouse, off the eastern extremity of Madeira, lies 21½ miles S.W. by W. ½ W. from the southern extremity of Baixo Islet, and a depth of 1,170 fathoms has been found in the channel between. From Fora Islet the bank of soundings extends in a narrow tongue, first S.E. by S. and then South, to and around the Desertas. In its narrowest part it is about 2 miles in width, and the depths along its centre vary from 46 to 80 fathoms, bottom of sand, coral, shells, or rock; in fine weather, fishing boats frequently anchor on it.

The DESERTAS, to the S.E. of Madeira, are three narrow rocky islands, extending over a space of 12½ miles N. ½ W. and S. ½ E. The bank of soundings round these singular islands is tolerably regular, extending 1½ mile from the East side, and 2 miles on the West side, but off the western side of Bugio the 100-fathoms line is 3 miles distant. They have no permanent inhabitants, but are occasionally visited by the Madeira fishermen, or by herdsmen to attend to the cattle, sheep, and goats pastured on them. Orchilla is also gathered on them.

There is much danger to vessels passing close under the lee of these islands with strong breezes, in the violence of the gusts from the high land, which are most variable, both in direction and strength. It is no uncommon thing to see the water whirled into the air, and then precipitated on the vessel's masts and decks.

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* The Eight Stones.—It is thought that Falcon Rock may be the site of a group of rocks marked on the old charts, and said to have been first seen in 1732, though the position then given is about 80 miles to the northward. They have been most carefully sought for, and great depths found in and around this locality.

The Tide sets by these islands, at springs, at the rate of 1½ to 2 miles an hour, the flood N.E. by E., and the ebb S.W. by W.; the rise is 7 feet.

Farilhão or *Sail Rock*, lying 100 yards North of the bold bluff at the North end of Chao Island, is a remarkable pinnacle 160 ft. high, 10¼ miles S. by E. ¾ E. from Fora Islet. At nearly 1¾ cable N.W. of it is a breaking rock, and a narrow rocky ridge of 11 to 19 fathoms extends about 1 mile N. by W. from it, with 24 to 40 fathoms close to its edge.

Chao Island, the northernmost, is 9 cables in length, and one-quarter of a mile in width at its North end, where it attains an elevation of 325 feet. It rises from the sea in high cliffs, and its surface is quite flat, composed of light soil, with rocks and stones, covered with long coarse grass, and a few aromatic herbs. Near its centre is a pond of turbid water. There are several rocks off its northern and southern extremities. Boats can land in a cove on its western side, named *Santa Maria*.

The channel between Chao and Deserta Grande, is 1¾ cable wide, but is so obstructed by rocks that boats can only use it in fine weather.

Deserta Grande, the largest and most elevated of these islands, is 6¼ miles long, by 1 mile in greatest width. The northern part consists of two ridges of hills, with a ravine or valley between them, in which, at the foot of a green hill about East of Pedregal Point, is a small house, and near it two ponds or reservoirs of turbid water; a few yards farther down the valley is a delicious spring, though yielding but a limited supply. From this point, to the South end, the island consists of one continuous ridge of high land, reaching its greatest elevation of 1,600 ft. in the central part of the island.

The East coast consists of a rugged, broken, irregular line of cliffs. The West coast also consists of high broken cliffs, with some rocks close to their base. Off *Pedregal Point*, 2 miles from the North end, is a detached rock, with high land towering above it to more than 1,200 ft. in height. About two-thirds of a mile northward of this point, is the little cove of *Castanheira*, where there is a boat landing-place, marked by a detached rock. *Ponta de Boqueirão*, the South point, has a rock close to it, but the point is otherwise steep-to and clear.

Bugio Channel, between Boqueirão Point and Bugio Island, is 7 cables wide, and clear, having depths of 8 to 20 fathoms.

Bugio Island, the *South Deserta*, is 4½ miles in length, but nowhere half a mile in width, its eastern side forming a slender bight. Its shores consist of rocky cliffs, of less altitude than those of the Deserta Grande, surmounted by a very sharp serrated rocky ridge of hills, which runs the whole length of the island. There is a gap in this ridge, near the centre of it, which at a distance gives it the appearance of two islands. The highest peak on the North part is 1,300 ft., and that on the southern part 1,070 ft. in height. *Ponta d'Agulha*, the South extreme, is situated in lat. 32° 23′ 15″ N., long. 16° 27′ 10″ W., and has a few rocks quite close to it. The 100-fathoms line passes about 1½ mile southward of it.

MADEIRA.—The date and manner of the discovery of this beautiful island are involved in some obscurity. The most probable is the romantic tale of an Englishman of good family, named Robert Machim, and Anne D'Arfet, two lovers, who, fleeing from the wrath of the lady's friends to the shores of France, were driven by a storm far away to sea, and after 13 days met with this unknown and uninhabited island. Here they landed, and in the course of a few days the lady died, from the privations which she had undergone, and Machim was found dead on her grave five days later. There are some variations in this story, both in date and particulars; 1344 has been given as the date, probably erroneously, but it was some time during the reign of Edward III. (1327—1377).* Before their death the ship had been driven off by a storm, and the remainder of the crew afterwards departed and reached the coast of Africa in their boat, where they were made prisoners by the Moors, and also found their companions and others in the same plight. Subsequent to the year 1416, a number of prisoners were ransomed from the Moors, under the will of a Spanish prince, but the vessel in which they were returning was captured by the Portuguese navigator João Gonsalvez Zarco, who liberated all but a Spaniard named Juan de Morales, from whom he heard of Machim's discovery.

Zarco had previously discovered Porto Santo, as narrated on page 755, and with Prince Henry's permission he again sailed in search of this other island, first landing at Porto Santo. Here the settlers drew his attention to a dark cloud constantly seen in the S.W., and Juan de Morales conjectured this might lie over the island they were in search of. Setting sail, on July 1st, 1420, they discovered the point now called Cape San Lourenzo, and named the island *Madeira*, a Portuguese word meaning *wood*, on account of the thick forests with which it was covered. During their explorations they found the wooden cross marking the grave of Machim and his lady, and what is said to be a portion of this cross is still shown in the little church of Machico. Returning in 1421, he erected a chapel over the grave, and founded the city of Funchal, so named from the *fennel* which there grew in abundance. Madeira has since remained a dependency of Portugal, with the exception of its occupation by English troops in 1801, and again from 1807—1814.

Madeira consists of a mountainous mass of land, 32 miles in length, N.W. by W. ½ W. and S.E. by E. ½ E., between San Lourenzo and Pargo Points, 12½ miles in its greatest breadth, between Cruz and San Jorge Points, and about 79 miles in circuit, with an area of about 240 square miles. It is of volcanic origin, though there are but few signs of craters, as at Caniçal on *Mount San Antonio*, forming the S.W. side of the valley of Machico, and at Caniço, about midway between this and Funchal.

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* See "The Life of Prince Henry of Portugal, the Navigator," by R. H. Major, F.S.A., &c., 1868, pages 66—77. Senhor J. I. de Brito Rebello, in a supplement to the "Diario de Noticias," Lisbon, March 4th, 1894, published in commemoration of the fifth centenary of Prince Henry's birth, rejects the story of Machim and his lady-love as being absolutely legendary, and suggests that the "capitania" of Machico was named after a seaman of that name, who was among the discoverers of the island, and died there.

Pico Ruivo, its highest peak, is well defined, attaining an altitude of 6,056 ft. near the centre of the island, and for 2¼ miles to W. by N. of this extends a ridge with peaks not far inferior in elevation, forming the northern edge of the stupendous ravine of the *Curral*, one of the wonders of Madeira. The western side of this is formed by a ridge, of which the rocky summit of the *Pico Grande* is 5,391 ft. high. Within 1 mile South of Ruivo is a ridge of peaks of nearly equal elevation, amongst which the three remarkable peaks of the *Torrinhas* are 5,980 ft. high. To S.S.W. of these is *Pico Sidrão*, at half a mile S.E. of which is *Pico Arriero*, 5,893 ft. high. These may be considered to form the axis of the island, from which the mountains generally slope gradually to the South, but on the North, with few exceptions, they drop precipitously on to the bold high coast.

Through the middle of the western half of the island runs a ridge, with peaks under 5,000 ft. elevation, and near its centre is the *Paul da Serra*, a wide plain. The eastern part of the island is less elevated than the West, though it is all very mountainous. In fact, the characteristic feature of Madeira is the number and picturesque outlines of its mountains, separated by deep precipitous ravines and gorges, which in places appear to cut through the highest of them almost to their very base.

The *Curral*, a few miles N. by W. from Funchal, is one of the grandest scenes in the world, though its name means simply a sheepfold. It is an immense valley, completely surrounded by mountains, whose sides are literally perpendicular, in no part being less than 1,000 ft. high. Round a part of these cliffs is a narrow road cut out of the solid rock, leading to the garden houses and country plantations. Looking from this road over the Curral, it seems like an unfathomable abyss, filled only by clouds and vapours rolling in a constant motion over each other.

The distance to which Madeira ought to be seen from the deck is about 90 miles; but, of course, at this distance, it would require a very clear atmosphere. Sir Andrew Lang stated that on leaving Madeira for the West Indies, December 26th, 1822, the Pico Ruivo was distinctly visible when the ship had reached 75 sea miles from the anchorage at Funchal, bearing N. 40° E., at $2\frac{1}{4}^{h}$ p.m.; but it was lost sight of soon afterwards, from the thickening atmosphere.

Madeira, together with Porto Santo and the Desertas, was carefully surveyed by Captain A. T. E. Vidal, in H.M.S. *Styx*, in 1843.* The island possesses no good harbour, the coasts being generally high and rugged, with an occasional beach of sand or shingle. The shores are bold, with only a few off-lying rocks. The so-called "ports" are simply boat harbours, used by fishermen and coasters. Fish, of various kinds, abounds around the coasts, and forms an important article in the food supply of the inhabitants.

The soil is very fertile, but the cultivation is confined to the coast, or to the bottoms of some of the valleys, and occupies altogether a very small proportion of the surface. On its South side cultivation rarely extends more than 2 or 2½ miles from the sea, and not more than half that distance on its North side. Below the elevation of 1,200 ft., tropical fruit, flowers, and vegetable productions are grown, such as palms, bananas, sugar-cane, coffee, &c. In 1892, the sugar crop amounted to 200 tons, a large increase being expected later on. Between 1,200 and 2,500 ft., the productions of the temperate zone are cultivated, but the greater part of this area is covered with vineyards. The wheat, barley, maize, and other grain raised is usually about sufficient to supply one-third of that consumed by the inhabitants. Above 3,000 ft., the sides of the mountains are wild and uninhabited. No serpents are found on the island, but the lizard is plentiful.

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* Among the numerous recent books published on Madeira, we may mention "The Climate and Resources of Madeira," by Dr. M. C. Grabham, F.R.G.S., 1870; "Madeira, its Climate and Scenery," by Jas. Y. Johnson, 1885; and "Madeira, its Scenery and How to See it," by Ellen M. Taylor, 1889.

Thus, here may be found almost every European and tropical luxury. The myrtle, the geranium, the rose, and the violet, may be seen on every side. The geranium, in particular, is so common, that the honey is strongly impregnated with its odour.

Water, of excellent quality, is abundant. Copious springs are found everywhere; even the streams at the bottom of the ravines, fed by the mountain mists, are never dry in the hottest season; and the height from which they descend enables the inhabitants to divert the course of the water at any elevation or in any direction; the whole cultivated region, therefore, is irrigated on all sides by these *levadas*, or water-courses.

In fine weather—and it is fine at Madeira nine months in the year—the view of this steep and lofty island, covered with bright verdure, and enlivened by numerous scattered houses, as white as snow, is very striking to a stranger who arrives from the low and tame-looking shores of the South coast of England.

The Climate of Madeira, generally, is delicious, and strikes with peculiar charm to a stranger, whom a short voyage has transferred to it from the very midst of the gloom and chill of an English December. Indeed, the great natural distinction of Madeira is the climate, which, taken altogether, is perhaps the finest in the world.*

In January and February very boisterous South and S.W. winds are sometimes experienced, but N.E. winds prevail as a rule. In February, there are sometimes sudden shifts to East and E.S.E., frequently followed by short gales, with thunder and heavy rain. It often happens that while rain is falling on the North coast, it is clear and fine on the South.

In March, N.W. winds prevail, sometimes causing a heavy surf at Funchal, rendering cargo operations difficult. There may be heavy falls of snow on the mountains during March and April, the weather being usually very unsettled during the latter month. The N.E. Trade Wind sets in about the middle of April, and continues until the end of September, Madeira being outside its limits during the rest of the year.

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* According to Mr. Johnson (pp. 256—274) the mean monthly temperature, from continuous observations during the 19 years 1865—1883, taken at the Fortaleza, Funchal, at an elevation of 82 ft. above the sea, is as follows:—January, 60·53°; February, 60·35°; March, 60·53°; April, 62·6°; May, 64·67°; June, 67·72°; July, 71·15°; August, 72·86°; September, 72·82°; October, 69·17°; November, 65·39°; December, 61·97°; the mean for the year being 65·76°. The highest temperature registered was 90·5°, in July, 1882, and the lowest, 45·68°, March 11th, 1883. The average annual rainfall is 26 inches, varying between 49 inches, in 1867, and 15½ inches, in 1877. The year is, therefore, one summer, with comparatively little alteration of temperature or hue.

In May, June, and July, the nights are generally clear, and the days cloudy, regular land and sea breezes being found near the shore, and N.E. winds in the offing. August and part of September are fine and warm, and the *Leste* (described below) is then sometimes experienced.

About the middle of October the periodical rains set in, and last about a fortnight, frequently commencing with strong S.E. winds, which veer to S.W. and round to N.W., when the weather clears and becomes fine. After the rains follows the season known as St. Martin's summer, with N.E. winds. Fine weather is generally experienced in November and December, with prevailing N.E. winds, but occasionally there are gales or thick weather.

Gales or gusty weather are very rarely experienced from May to the end of September. Gales are principally to be apprehended in November and December, commencing a few points on either side of South, gradually veering round to the westward, and terminating in the N.W. The barometer is highest with N.E. and lowest with S.W. winds.

In the winter months eddy-winds and squalls, proceeding from the high land, are frequent and severe, and the ships are often forced to put to sea from Funchal Road. Severe westerly and S.W. gales, with rain, then frequently prevail, and prevent sailing vessels regaining it for some time. At these periods, Madeira and the Desertas are often obscured in fog. The squalls have been found so sudden and violent near the Desertas, and about the S.E. end of Madeira, as nearly to overset the ships in the vicinity; and many have been driven by them far to the eastward.

The wind called the *Leste* occurs in August and part of September, and, as its name implies, comes from the East, although all East winds are by no means *Lestes*. It appears to be of the same kind as the *Harmattan* of Western Africa, and is of a hot, close, drying nature, particularly oppressive to some constitutions, which it affects by languor, headache, and a parching of the skin and lips. What is remarkable, the residents are those whom it most disorders in this way. Visitors in general suffer much less; and the invalids are never so well as while it lasts. A peculiar clearness and cloudlessness in the atmosphere are among the invariable indications of the Leste, and the weather during its continuance is most delightful; the sky of a deep blue, so stainless that one might fancy it had never been sullied by a cloud; with a transparency in the atmosphere, which, like the effect of moisture, seems to bring out fresh hues from every object.

At times, but not frequently, the Leste is accompanied by a strong wind from the E.S.E., with hazy weather, though still delightfully warm and pleasant. The nights, too, are delicious—soft and balmy; and with the moon shining in summer brightness, and the orange trees in flower, the air is loaded with perfume. With the departure of the Leste, rain almost invariably follows. Dust from the African desert is frequently deposited by this wind in considerable quantities.

According to the careful observations of Dr. Taylor at Funchal,* the Leste is a very dry and parching wind, and sometimes very hot, blowing from the E.N.E. or E.S.E., and doubtless originates on the heated deserts of the Sahara. Its occurrence is quite uncertain, but it is most frequent in July, August, and September. Its duration may be only one day, and it may last up to six and seven days. The force of this wind is often considerable, from 4 to 5, or even 6, Beaufort's Scale (page 104). As far as Dr. Taylor's observations went, the barometer shows no certain or decided movement. The sky is perfectly cloudless, except for a low and ill-defined bank of cloud on the East and S.E. horizon. There is, however, a decided haze, which gradually obliterates the horizon, and renders the Desertas invisible from Funchal. The highest temperature reached is rarely much above 90°. When the Leste has blown itself out, it is almost invariably followed by rain or thick mist, as it becomes gradually replaced by the cooler prevailing N.E. wind.

Tides.—It is high water, on full and change, in Funchal Road, at $12^h\ 48^m$, or about the same time as at the Azores; springs rise 7 feet. The flood sets to the north-eastward, 1¼ mile an hour at springs, but off San Lourenzo Point it sometimes attains a velocity of 2 miles an hour.

At the census of January, 1887, the population of Madeira amounted to 135,165, chiefly engaged in agriculture, and mostly very poor, many emigrating as a matter of necessity. The towns and villages are invariably situated on the sea-coast, and commonly at the outlet of a ravine; but where the bottom is fertile, and the surface permits, the cabins, and *quintas* or country seats of the wealthier class, are often scattered up a considerable extent of the valley.

The main article of export is wine, with fruit, vegetables, &c., their value in 1892 being estimated at £163, 001, of which 5,077 pipes (92 imp. gal.) of wine represented £146,009. The imports are chiefly coal, wheat, maize, molasses, &c., valued at £194,489 in 1892.

In the year 1809, 15,363 pipes of wine were exported from this island by English ships. In the year 1851 the shipments to all countries were reduced to about 7,000 pipes, after which time, in consequence of the vines being attacked by disease, causing the failure of successive vintages, the wine trade gradually dwindled away till the year 1861, when the export was reduced to about 360 pipes. With the renewal of the vineyards by American vines, the export trade of the wine has been increasing since the year 1861, and in the year 1880 the export to all countries, but chiefly to Great Britain, amounted to 3,691 pipes; and in 1892 to 5,077 pipes. At present the annual vintage averages about 7,000 or 8,000 pipes.

With the general increase of steam navigation, the number of vessels resorting to the port of Funchal for coaling purposes has steadily augmented, as shown by the increasing quantity of coal imported, which amounted to 70,894 tons in 1892. In that year, the number of vessels calling here was the largest recorded, being 702, with a total tonnage of 1,084,489, of which 402 vessels, 696,616 tons, were British.

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* An "Account of the "Leste, or Hot Wind of Madeira," by H. C. Taylor, M.D., in the "Quarterly Journal of the Royal Meteorological Society," vol. xvii., 1891, pages 217—226.

The Money of Madeira is Portuguese, though the English sovereign and half-sovereign are current nominally at 4½ and 2¼ milreis respectively, but this varies much according to the rate of exchange. Silver coins are only legal tender to the amount of 5 milreis, and consist of pieces of 500 reis (worth about 2s. 3d. nominally), 200, 100 (the tostão), and 50 reis. The bronze coins are of 40 reis (worth about 2d.), 20 (the vintem), 10, and 5 reis. The *Milreis* (1,000 reis) is often called a dollar, and the piece of 500 reis a half-dollar.

The bank of soundings around Madeira is widest off its western end, where the 100-fathoms line is found at 4½ or 5 miles off shore. It is narrowest along its southern coast, the same depth being found at half a mile off Garajao Point, varying elsewhere from 1 to 2 miles off. Along the northern coast the bank is wider, particularly in the eastern part, and reaching from 1 to 3 miles off.

FORA ISLET, lying off the long but rugged and narrow peninsula forming the eastern extremity of Madeira, is 4 cables long N.E. and S.W., and the peak near its North end is 352 ft. high. The best landing is on its S.E. side, it having rocky cliffs elsewhere. The islet is steep-to in all directions, except its S.E. side, off which are some dangerous rocky patches surrounded by deep water. The outer one, which lies nearly 4 cables S.E. by S. from the lighthouse, is a small rock with 4 fathoms on it, and 13 and 26 fathoms close to it. The inner patch is more extensive, bearing from the lighthouse about S.E. by S. ½ S., 3 cables; and upon this are several rocks, some with 15 ft., others with only 4 ft. over them. Vessels must therefore give the islet a good berth in rounding it.

The LIGHTHOUSE, on the eastern part of Fora Islet, is an octagonal tower 41 ft. high, showing a *fixed bright* light, varied by a *bright flash* every half minute, at an elevation of 343 ft. above high water, and visible 25 miles in clear weather. Its position is lat. 32° 43′ 15″ N., long. 16° 39′ W.

Close westward of the lighthouse is the *Signal Station*, connected with Funchal by telegraph, and passing vessels can be reported. Storm Signals are exhibited here.

The western end of Fora Islet is separated from San Lourenzo Point by a channel 200 yards wide, with 3 to 4 fathoms in it at low water, rocky bottom; but a swell or strong breeze with opposing tide causes so great a turmoil in it, that it is frequently unsafe for boats.

San Lourenzo Point, the eastern extremity of Madeira, is a narrow rugged peninsula, less than 1 mile in length, and only connected with Furada Point by a rocky ridge, nearly insulated at high water. *Ponta Furada* is a bold basaltic point, surmounted by a hill 550 ft. high, and the extremity is pierced by a fine lofty arch, made by the waves. At 1¼ mile W.N.W. of this is *Gaivolas Point*, *Labra Bay* between forming a temporary anchorage for steamers, with a sandy beach affording fair landing. Above Gaivolas Point rises a rocky hill, 380 ft. high, surmounted by the conspicuous small white chapel of *Nossa Senhora da Piedade*. Westward of this, quite across the narrow neck which forms the East extreme of Madeira, occur some curious fields of fossils, similar to those described at Porto Santo.

Caniçal Point and village are 1⅛ mile W. by N. of Gaivolas Point, the coast between being lower. To the W.S.W. of this the cliffs are bold and high, as far as Machico Bay, 1½ mile distant, off the N.E. point of which rocks extend for about 3 cables.

Machico Bay is a most romantic cove, with a sandy beach, celebrated in tradition as the place where the first discoverer, Robert Machim, landed with Anne D'Arfet; the village church is supposed to cover their graves. The people here own a considerable number of fishing-boats. *Ponta Queimada*, the S.W. point of the bay, is cliffy, with some flat rocks close off it.

At 1¼ mile S.W. ½ W. from Queimada Point is *Ponta de Santa Catarina*, close off which is a steep rock, 36 ft. high, but the whole coast is bold, with no outlying dangers. *Ponta Guindante* is the next projection, the coast between forming a bay; in its North part is the village of *Santa Cruz*. On the S.W. side of Guindante Point is the village of *Porto Novo*, in a small shingle bay, where a considerable stream finds its outlet.

Atalaya Point, 9 cables S.W. by W. ½ W. from Ponta Guindante, has a singular small pointed peak on the cliff, close to it. From this *Ponta Oliveira* bears W.S.W., 1 mile; it is a clean rocky point, steep-to, upon which you can land, and the ascent from it is easy. From hence Cape Garajao bears W. ½ N., distant 1 mile.

Cabo Garajao, the *Brazen Head*, the East point of the Bay of Funchal, 11⅔ miles W. by S. from Fora lighthouse, is a bold rocky headland, jutting out at right angles to the line of coast, and very steep-to. It is formed by perpendicular cliffs of reddish-yellow tufa, and above them is a narrow hilly ridge of land, crowned with a rocky knob or knoll, 420 ft. above the sea, which particularly distinguishes the head when seen from the westward. On its western side is a small shingle beach.

The BAY of FUNCHAL is bounded on the East by the Brazen Head, and on the West by *Ponta da Cruz*, bearing from it W. by N. ½ N., distant 5 miles. The coast to the West of Cape Garajao is a series of rocky cliffs and small stony points as far as St. Iago Fort, which is exactly midway between the two extremes of the bay, and at the East end of the town of Funchal. Westward of this a black shingly beach fronts the town, terminating at *Fort San Lazaro*, where the coast again becomes rocky and cliffy, to Ponta da Cruz.

Ilheo or Loo Rock, forming a conspicuous object from sea, lies 1 cable off shore, bearing S.W. from San Lazaro. It is 70 ft. high, and 100 yards in length, and the fort on it is only accessible by steps on its northern side. On it is a *Signal Station*, where Storm Signals are also shown. The rock is now connected by a mole with the *Pontinha*, about 120 yards to W.N.W.; this is an artificial embankment, carried out from the land in a S.E. direction to a small islet. The mole thus shelters a small area, with depths of 3 to 5 fathoms, sand over rock, known as *Pontinha Bay*. Vessels lie moored with their heads secured to the rock, and stern-fasts to the opposite shore.*

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* The mole was seriously damaged by a storm soon after its completion in 1890; it is, however, proposed to repair it, the estimated cost being £27,000. The remains still afford some shelter.

Light.—At the eastern part of Loo Fort is an iron staff, on which is shown a *fixed red* light, elevated 112 ft. above high water, and visible 6 or 8 miles in clear weather.

FUNCHAL, the capital of Madeira, was thus named by Gonsalvez Zarco, when he first landed here, on July 3rd, 1420, from the quantities of fennel (*funcho*) found growing. The town has a sea-front of nearly a mile, and has a very pleasing appearance from the sea, from which it rises in a kind of amphitheatre formed by the mountains. The contrast of the white buildings and villas with the green mountains forms a beautiful picture, which is much heightened by the bold quadrangular Loo Rock, with its embattled summit, commanding the harbour, in the foreground. The town proper does not extend more than a quarter of a mile from the beach, the houses beyond being situated amidst luxuriant gardens and vineyards, and above all, at an elevation of 1,965 ft. and 2 miles from the sea, is the church of *Nossa Senhora do Monte*, seated on a terrace just half-way up the mountain, and commanding one of the most enchanting views in the world. The town is traversed by three *ribeiras* or mountain torrents. The cathedral, near the centre of the town, is a fine building, and westward of it is a *passeio* or open space, and beyond that the *Terreiro da Sé*, a very pleasant public garden and promenade.

Among the most conspicuous objects are Loo Rock, *Pico Fort* (known also as the Citadel) on a rocky eminence over half a mile to N. by E., the Castle of San Lazaro, and the Fortaleza, the residence of the governor, 300 yards westward of the latter. On the East side of the Fortaleza, a stone pier, or landing place, was completed in 1892, reaching into a depth of 2½ fathoms at low water; it is about 250 ft. long, and 42 ft. wide, with landing steps on both sides, where boats can land even with a moderately heavy surf running. On the beach, close eastward of the pier, is *Benger's Pillar*, 95 ft. high, of a dark colour, surmounted by a signal mast and yard, and appearing like a black chimney from the offing; it was built in 1796. Eastward of this is the *Alfandega* or custom-house, beyond which are the fruit, meat, and fish markets, built on the beach. At one-third of a mile beyond these is *Fort St. Iago*.

At the census in 1887, Funchal and its suburbs contained 37,240 inhabitants. It has always been a favourite place of resort for invalids, owing to its climate, but the difficulties of locomotion, from its mountainous character and the peculiarity of its paving, must render exercise very difficult for persons in bad health. Some attempt has been made to remedy this by the construction of a new road to the westward. There is a seamen's hospital here, and a Sailor's Rest.

Fresh meat, poultry, vegetables, and fruit, are abundant, also excellent fresh water. There are no facilities for repairs of any magnitude, but *Coal* is stored in large quantities, and can be put on board from lighters at the rate of 600 tons or more a day. A coal hulk is moored about half a mile S.E. by E. ½ E. from Loo Rock. The services of a steam-tug are also available. These facilities have led to a great increase in the number of steamers calling here, the dues on vessels calling only for supplies being confined to a charge for customs officers; the pilot's fees are about 10s.

Tonnage and anchorage dues were abolished in 1888, and will probably not be again imposed.

There is frequent communication with Europe, &c., by several lines of mail steamers; and four telegraph cables, belonging to the Brazilian Telegraph Company, are landed near Fort St. Iago, two from Lisbon and two from St. Vincent, C.V.

Directions.—Vessels bound to Madeira from the northward are recommended to make Porto Santo, in the first instance, and thence proceed between Fora Islet and the Desertas. Madeira is often so entirely clouded over, as not to be visible at the distance of 15 miles; in fair weather, when abreast of Porto Santo, the island commonly appears as one great mountain, with its summit hidden in the clouds, and shortly after appear the Desertas. Having passed those islands, you will soon perceive the ships in the Road of Funchal; and from their riding, it will be seen how the wind is in the road, as it is common to have a strong breeze from the N.E. or East, on passing the Desertas, when, at the same time, the wind in the road is from the S.W. or W.S.W.

Sailing vessels from the eastward, bound to Funchal, with the wind north-easterly, will pass between the Desertas and Madeira, and the north-easter will carry them to the offing of the Brazen Head, the East point of the Bay of Funchal, westward of which calms or baffling light winds may be found. In the night, ships may keep over toward that bluff point, and, with her boats towing ahead, when becalmed, luff up into the stream of the land wind, and by that means fetch the anchorage. In the day, they should keep 2 or 3 miles off the land, to avoid being becalmed under it, and to gain the stream of the N.E. wind, until the town bears about North, when haul in, and after passing through the calm region, the sea breeze will take them to the anchorage.

If, from over-caution, or other reasons, vessels fall 5 or 10 miles to leeward of the road, they should then keep plying up in the stream off the valley, until they gain the vein of the sea breeze. In working in with the land breeze, it is best to make short tacks, opposite the valley; as here both the land and sea breezes are most regular.

Small vessels, from North America and the Western Islands, come in, generally, round the West end of the island, but are frequently becalmed a considerable time under the high land there. For this reason, ships, on leaving Funchal, should make sail with the land wind, and stand directly off from the road; ships bound to the southward, by taking a contrary method, having continued several days becalmed under the western part of the island.

Land and sea breezes prevail during summer, off the valley of Funchal, requiring some judgment to bring a sailing vessel to the anchorage. The sea breeze generally sets in about 9 or 10 a.m., blowing between S.W. and W.S.W., and even more westerly, gradually dying away towards the evening. The land breeze springs up about 9 or 10 p.m., and dying away about 2 or 3 p.m., leaves an interval of 4 or 5 hours calm.

Anchorage.—Captain FitzRoy remarks (vol. ii., page 46):—" Seamen are often deceived, when about to anchor in Funchal Roads, in consequence of the sudden transition which they have probably made from a low shelving coast to an abrupt and high mountain side; for the bottom of the anchorage slopes away as suddenly as the heights overlooking it, and the anchor must, indeed, be let go upon the side of a mountain. Hence ships seldom go close enough, unless guided by a person who knows the place. Closing the land quickly, after passing some time at sea—approaching high cliffs or hilly shores, after being for a time accustomed to low coasts—or nearing a flat shore, after the eye has been used to precipices and mountains—almost always is a cause of error in estimating distance, however experienced a seaman may be."

When coming into the road, with a brisk wind, sail should be reduced and secured in time, to prevent having too much way through the water, at the moment of anchoring; and ships should be brought up with their head to seaward; for thus, in case of any accident in bringing up, sail may be made off shore, or otherwise, as required.

In summer, vessels may anchor anywhere in the bay, in depths of 16 to 21 fathoms, less than half a mile off shore, and, at this season, sailing vessels generally anchor opposite the Custom-house, in 20 to 30 fathoms, with the Cathedral bearing N.N.W. But the best anchorage, especially in winter, is to the S.S.W. or S.W. by S. of Loo Rock, keeping Pico Fort about midway between Loo Rock and the Pontinha. On this bearing steamers anchor in 12 to 18 fathoms, 1½ to 3 cables from Loo Rock; sailing vessels anchor about 1 cable farther off, in 25 to 35 fathoms. The anchorage for vessels in *quarantine* is farther to the westward. The soundings over the bay are regular, with a bottom of fine dark sand, and a little mud. Merchant vessels are forbidden to anchor off Funchal, between sunset and sunrise, but vessels carrying mails and passengers are visited by the port authorities at any hour of the day or night.

With Loo Rock and the citadel in one, bearing N. by E. ¼ E., and the Cathedral steeple about N.E. ½ N., the anchorage appears equally good, in 35 fathoms, stiff ground. With the same marks, about 1 mile off the Loo, there is good ground in 45 fathoms. To the westward of this line the ground changes to sand and rock, and to the eastward it has a sudden declivity from 50 to 55 fathoms, stiff clay ground, to 100 fathoms, rock, and then no ground. It is necessary to sight the anchor occasionally, if detained here.

In case of a S.W. gale, which may be frequently expected in winter, the situation with the Loo and citadel in one, or the citadel just open to the westward of the Loo, will be found most convenient. On the contrary, the citadel well open to the eastward of the Loo, is the best situation when a south-easter may be expected.

. Steam vessels, prepared to weigh at short notice, anchor off the town, in less than 10 fathoms. The Cape mail packets, and other steamers regularly calling here, usually lie in about 7 fathoms, with the Pontinha appearing open northward of Loo Rock.* For coaling, the latter position is most convenient, and by hoisting Commercial Code signals on approaching the Signal Stations on Pargo Point, Fora Islet, and Loo Rock, showing the number of tons required, by the time the vessel has anchored, the lighters will be ready to come alongside. The coal is filled into bags, and the derricks and steam-winches should be in readiness to hoist them in.*

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* TELEGRAPH CABLES.—To avoid injuring the Telegraph Cables, vessels must not anchor within the arc limited by the arms of a black *beacon*, eastward of Fort St. Iago; these arms point S.W. ½ W. and S.E. Behind it is the church of N. S. do Socorro, and in anchoring, the tower of this should not be brought to bear East of N.E. ½ E.

Before the days of chain cables, it was recommended that when in 38 or 36 fathoms, with Loo Rock bearing about N. by E., the port anchor should be let go with two cables on it, for should there be a fresh breeze from the eastward it will be scarcely possible to bring up, until the splice is veered a good way out. It is requisite to ride in the road with a whole cable, and with a splice so situated that you may be able to cut near it, should circumstances unfortunately compel you to put to sea without weighing anchor. While riding, keep a slip-buoy on the cable, have a kedge anchor and a 9-inch hawser to the westward, to keep the ship steady, with the hawser on the starboard bow, as the wind generally veers from the eastward to S.W. and West. When the land wind makes a cross, the end of the hawser may be shifted.

In fine weather, the most convenient landing place is the new pier, as there is usually a heavy surf on the beach. Notwithstanding this, the native boatmen are so expert, that accidents have seldom happened. There is very good landing, but at an inconvenient distance from the town, at the steps on the East side of the Pontinha.

Those riding in Funchal Roads should be very active when they observe a swell coming in from the S.W. or S.E.; at this moment, no time is to be lost in getting under way, for the swell indicates that a gale is certainly coming on; particularly so in the months of December and January, generally the commencement of the rainy season. Should it come on to blow very hard from the westward, the best mode is to run to leeward of the Desertas, where shelter from the wind may be found, and water perfectly smooth; thus you avoid the risk of losing sails, by heaving to windward.

Admiral FitzRoy says (vol. ii, page 46):—The roadstead of Funchal is well-known to be unsafe in S.W. gales; and there can be no doubt that the most prudent plan is to keep at sea while they last; but I have been told by old traders to Madeira, that ships sometimes remain at anchor, about half a mile from the Loo Rock, and ride out S.W. gales without difficulty; the under-tow being so considerable, that their cables are little strained.†

The Coast, between the Pontinha and *Ponta da Cruz*, 1¼ mile to West, has a broken outline of rocky cliffs, points, and bays. The bay to the West of the Pontinha is half a mile across, and its shores are composed of steep cliffs, with a high bold bluff at its West extreme. Along the base is a beach of sand, extending as far as the watercourse named *Ribeira Secca*. The whole of this bay is comparatively shallow, with some off-lying rocks, and appears to offer the best position in Madeira for any artificial harbour works. The *Gorgulho*, a detached sugarloaf rock, lies off a pretty little bay, half a mile farther West, and at 4 cables North of it is *Monte da Cruz*, 862 ft. high. Hence there is a succession of rocky cliffs for another half mile to *Ponta da Cruz*, composed of high vertical cliffs, at the S.W. extremity of which there is a semi-detached pointed rock, surmounted by a small iron cross. This rock is the South extremity of Madeira, and is in lat. 32° 37′ 18″ N., long. 16° 56′ 40″ W.

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* We are indebted to Messrs. Blandy Brothers for these particulars as to coaling.

† These statements require some modification. In October, 1842, the island was visited by one of the most dreadful storms that had occurred since the great flood of 1803, which swept 400 persons into the sea. On the 25th it blew a tremendous hurricane from the South, which, with the terrific sea, drove four out of the six vessels lying here on shore, with total destruction, and nearly all the crews were lost.

At Ponta da Cruz the coast turns abruptly to the N.N.E., for two-thirds of a mile, and then takes a W.N.W. direction, thus forming the bay called *Praya Formosa*, the angle being filled with a wide shingly beach. At 1⅓ mile from Ponta da Cruz is the mouth of the *Socorridos*, a mountain stream, perhaps the largest in Madeira, which drains the celebrated valley of the Curral. On the West side of its mouth is a small bold rocky point, round which are the village and little boat harbour of *Camara de Lobos*. The West side of this is a narrow wavy line of black lava, running out 270 yards to the South. The sides of the mountains around the little town are covered with quintas and vineyards, and are said to form one of the finest wine and sugar districts of the island. West of it stands a small fort, built on a rock near the shore.

CAPE GIRAO, a magnificent headland, 3⅓ miles N.W. ¼ W. from Ponta da Cruz, is the termination of a ridge of mountains lying westward of the valley of the *Jardim da Serra*. The cape is nearly perpendicular for 1,920 ft. above the sea, which nearly washes its base; upon the high land above it is a grove of pine trees, 2,168 ft. above the sea, and the hills continue rising until they reach the head of the valley, at an elevation of 4,535 feet.

At 2 miles N.W. by W. from Cape Girão is the *Ilheo de Lapa*, a conical-shaped rock, in front of the village of Campanario. The coast to the East has a continuous line of stony beach; towards the West this characteristic alternates with clean black rocky points.

Ponta do Sol, 5⅓ miles N.W. by W. from Cape Girão, is a bluff rocky cliff, with some fragments of rock lying close in front of it; the largest of these is pointed, and had a small wooden cross on it. In a westerly gale and stormy weather the point appears surrounded with the colours of the rainbow, arising doubtless from the spray of the surf; hence, probably, or from a peculiar marking on the cliff, its name has been derived. The village is up the ravine to the West of the point; its church may be seen through the narrow gorge. North-westward of this the coast is a long wavy line of narrow stony beaches, above which are cliffs of small elevation, much broken by ravines and land-slips; one remarkable piece of cliff stands 1¼ mile from Ponta do Sol.

At 2¼ miles beyond Ponta do Sol is the village of *Magdalena*, at the outlet of a ribeira; 2 miles beyond this is another ribeira, and the space between is called the *Arco da Calheta*. At 4⅔ miles from Ponta do Sol is the town of *Calheta*, but little can be seen of it through the very narrow ravine. At a quarter of a mile West of it, above the cliffs, on a ridge of land, is a conspicuous long building like a monastery. *Ponta Galera*, 7 cables beyond Calheta, is a natural jetty of flat rocks of black basalt, 100 yards long. *Ponta Jardim*, 1⅛ mile N.W. ¾ N. from Ponta Galera, appears to be a landslip, with a small village and a chapel on it. The soundings off this part of the coast are regular, over dark sand, and extend off 1⅛ mile, with 30 fathoms at 1 mile to the S.S.W. of Jardim Point.

Paul do Mar, a village on the coast, is 1¼ mile N. by W. ½ W. from Ponta Jardim; here there is a waterfall, and a great landslip, the land being cultivated in terraced vineyards. A grove of pines above Paul do Mar is 2,030 ft. above the sea, while its horizontal distance from it does not exceed half a mile. This will give an idea of the bold character of the scenery. From Paul do Mar the beach of shingle and large stones extends 1½ mile to *Point Fajãa da Ovelha*, where it is broken through by a little spur of black lava. The cliffs here become more elevated, and above them the land rises with a steep ascent to the highest peaks of the western mountains, 4,271 feet. A chapel, elevated 1,623 ft., stands a quarter of a mile eastward of Fajãa da Ovelha, and between this and Pargo Point the cliffs are broken by numerous torrents, and faced by large rocks. About midway is the creek and fishing village named *Porto do Pargo*.

Ponta do Pargo, the western extremity of Madeira, is 2½ miles N. ½ W. from Ponta Fajãa da Ovelha; its bold rocky cliffs are 935 ft. high, the smooth-topped hill half a mile to the East rises to 1,380 ft., and on the heights, 1 mile East of the point, there is a church. Some rocks and large stones lie scattered around the base of the point.

A Signal Station is maintained on Ponta do Pargo, connected by telegraph with Funchal, and passing vessels can be reported. Storm Signals are also shown here. The position is lat. 32° 48′ N., long. 17° 16′ 10″ W.

The bank of soundings extends 5 miles off between W.N.W. and N.N.W. from Fajãa da Ovelha Point, with fairly regular soundings from 30 to 50 fathoms, light brown or dark gray sand, and occasionally rock. From these depths it drops very suddenly to 200 fathoms and over. The bank reaches 2½ miles N.W. of Ponta do Pargo, but a rocky ridge, with 8 to 20 fathoms over it, runs off 1½ mile N.W. by N. from this point, and occasions a heavy sea with westerly winds.

Between Ponta do Pargo and Ponta Tristão, 5 miles to N.E. by E. ¾ E., the coast consists of a wavy line of coarse stony beach, with high rocky cliffs rising abruptly from it. Above the cliffs the land rises steeply to the ridge of mountains, above 4,000 ft. high, and 2 miles from the sea. Numerous torrents run down the ravines, and two extensive landslips are terraced for vines.

The North Coast of Madeira is dangerous for sailing vessels, with northerly winds between N.W. and N.E., and they should consequently give it a wide berth.

Ponta Tristao, the North point of Madeira, is a bold bluff, 1,070 ft. high, off the foot of which are a few sunken rocks, extending 150 yards, but clear beyond. On the heights, nearly 1 mile to the South, is the parish church of *Magdalena*, 1,709 ft. above the sea. At 9 cables E. by N. ½ N. from the point, and about half a mile from the adjacent beach, is a singular cluster of flat rocks, a few feet above the sea, called the *Rochas de Rabaçal* With any sea, the surf rolls over them, but they are steep-to, with a deep channel between them and the coast.

Ponta Moniz, 1¼ mile E.S.E. of Ponta Tristão, is formed by a rugged mass of lava running out N.E. about 470 yards beyond the general line of coast, and looking as if it had flowed over and beyond the cliffs into the sea; it is cultivated with vines. On either side of it are detached rocks, and off the bluff are four others in a straight line. On the East side of the point is a small fort with a round tower; and 140 yards S.W. of the outer islet is a rocky point with another round tower, at which boats can land as at a jetty. The town of *Moniz* stands on the higher part of the point, the chapel being one-third of a mile from the landing-place. In front of the point, 120 yards off it, with no safe passage between, is an islet of the same name, 250 ft. high, composed of yellow tufa resting on black lava; its shores are precipitous, and it is the resort of numerous sea-fowl.

The little bay to the South, locally called *Porto Moniz,* is in fact a rocky bank, varying in depth from 2 to 10 fathoms. At 1 mile S.S.E. from Moniz Islet are a group of rocks, called the *Janellas,* lying near the outlet of that ribeira; they are five in number, the largest 130 ft. high, and of a yellow colour. At 3 miles S.E. by S. from the outer Janella is the point and village of *Seisal.* The point is a comparatively low, rocky, projecting piece of land, with a great variety of feature. The village stands on the top of the point, a short distance from the cliffs, and surrounded by vineyards. The best landing is on the largest rock at the East extremity of the point, which is, on this account, connected with the shore by a wooden bridge. To the S.S.E. of Seisal are two small bights, one known as *Porto da Serra d'Agoa.* Between this and San Vicente River, 3 miles to S.E. by E. ¼ E., and beyond this to Ponta Delgada, runs a narrow shingly beach, at the foot of high cliffs. The *Ribeira de San Vicente* descends from the summit of the island, and its outlet is marked by an isolated sugarloaf rock, standing a few yards within the beach, which has been excavated and converted into a chapel.

Ponta Delgada, 3¼ miles E. ¼ N. from San Vicente, is a comparatively low point, composed of rocky cliffs, with a village upon the top of it. The houses, which are numerous, and many of them pleasing and respectable, are scattered thickly among the richly cultivated vines and orchards, with a very pleasing effect. The church, large and handsome, is close to the sea. Close round the point, on its East side, is a small bay, with a little bit of fine shingle on it, which offers the best landing. Rocks and boulders extend 1½ cable off around the point, on which a tremendous sea sometimes breaks.

Ponta do Arco, a bold black point, is 1½ mile E. by S. ½ S. from Ponta Delgada, and nearly midway between are a few large detached rocks, the largest called *Rocha de Boa Ventura.* A group of low rocks lies off 230 yards to the W.N.W. of it, and abreast of it are two *ribeiras,* the larger named *Entroza,* with two white houses. At 2½ miles farther eastward is a larger rock named *Bacha.* Nearly three-quarters of a mile inland from Ponta do Arco is a conspicuous sharp, wooded peak, 2,746 ft. high, the summit of the Arco de San Jorge, a valuable station on the survey from its unmistakable peculiarity of feature.

Ponta de San Jorge lies 4½ miles E. by S. ½ S. from Ponta Delgada, the coast between being cliffy, with a narrow stony beach. San Jorge Point, in lat. 32° 49′ 40″ N., long. 16° 54′ 30″ W., is a bold, rocky bluff, rising nearly 700 ft. above the sea, and may be called the N.E. point of the island. A small low rock just seen above water, on which the sea commonly breaks, lies 3 cables S.E. by E. from its extremity.

Between San Jorge Point and Santa Anna Point, over 1 mile to S.E. ½ S., the cliffy coast forms the slender bay known as *Porto de San Jorge*, with some houses and a small fort at the mouth of a stream. At about three-quarters of a mile S.E. ½ S. from San Jorge Point is a large isolated rock, the *Ilheo de San Jorge*, 134 ft. high, one-third of a mile from *Santa Anna Point*. The latter point is formed by a gradually rounding narrow beach of large stones and coarse shingle, from which the land rises very abruptly, attaining an elevation of 1,100 ft., at one-fourth of a mile from the sea. The country around is well wooded and extremely beautiful; and the quintas spread over it are amongst the most favourite summer retreats of this island. A detached rock, 14 ft. high, lies a quarter of a mile S.E. of the point, and at 1 1-5th mile from the point, and 400 yards off shore, is *Tide Rock*, a small isolated rock, which uncovers at low water.

Ponta Cortada, a remarkable point, lies 2 miles S.E. by S. from Ponta de Santa Anna; above it rises a singular sharp peak, 1,730 ft. high, standing close to the edge of the cliff, and overlooking a large high mass of rock at its base, called the *Rocha do Navio*. Ponta Cortada has a very sharp termination, with deep water close up to it. *Ponta de Fayal*, 8 cables to S. ½ E., is comparatively low and narrow, and has a perpendicular rocky cliff along its N.W. side. At one-third of a mile E. by N. from it is a black basaltic rock, called the *Ilheo de Fayal*, with a sugarloaf rock in its centre, 72 ft. high, and steep-to. At 2½ cables S. by E. from the point there is a sharp, bold, rocky spur, the small town of *Fayal* lying above the small bay between them. The cliffs from which this spur projects rise to a considerable elevation, and form the sea-face of a singular flat-topped mountain, named *Penha d'Aguia*, or *Eagle Rock*, 1,915 ft. high.

Ponta da Cruz is the outer extreme of a small peninsula, at 1⅜ mile S.E. by S. ½ S. from Ponta de Fayal. It is surrounded by low rocky cliffs, and off it lie four detached rocks, the outer one of which is 2½ cables distant, with a breaking rock 1 cable to S.E. by S. ½ S. from it.

Porto da Cruz is the bight on the southern side of the peninsula; it is three-quarters of a mile across, with a shingle beach at its head, and here is also the little town of *Santa Cruz*, the last habitations seen on this part of the island; rocks and foul ground line its shores.

Between San Jorge and San Lourenzo Points the bank of soundings extends farther off than at any other part of the coast, except Ponta do Pargo, and the depths over it are tolerably regular, except in front of Ponta da Cruz. Its breadth hereabout is from 2½ to 3 miles, and the depth from 20 to 80 fathoms, the bottom generally of dark gray sand, and occasionally coral; from 70 and 80 fathoms the depth suddenly increases to 100 and 200 fathoms.

In February, 1885, the Channel Squadron anchored off Porto da Cruz, owing to a westerly gale rendering Funchal Road unsafe, and here rode securely, though exposed to violent squalls off the land. H.M.S. *Achilles* anchored in 34 fathoms, with Ilheo da Cruz bearing W. ¾ N., and San Antonio Point S. ½ W. Boats can land in a cove westward of the village.

Beyond Santa Cruz the coast consists of bold rocky cliffs, of no great height, but the land above them rises precipitously. *Ponta de San Antonio*, 2 miles to S.E. ¾ E., is a bold rocky point, with two rocks lying close at its foot; half a mile inland is a densely wooded mountain, 2,510 ft. high. A dreary ironbound coast, without inhabitants, extends for 5½ miles S.E. by E. ½ E. to *Ponta do Castello*, the cliffs of which are of reddish tufa, 534 ft. high, bold and perpendicular, and at half a cable off the bluff is a breaking rock. The shore throughout is broken into innumerable small coves and bold fantastic points, with numerous detached rocks, but in no case beyond 2½ cables off shore. At 1¾ mile from Ponta de San Antonio, and about half a mile inland, is a high green woody peak, named *Castanhas*, rising 2,058 ft. above the sea. The land East of it has a steep descent to Caniçal, on the South coast. At 3½ miles from San Antonio Point is *Ponta Bode*, a bluff, with a bay on each side of it, and at 1½ mile farther is *Ponta do Rosto*, with a group of rocks off it.

Brancas Islet, about 250 yards N.W. of Castello Point, is a high conical rock, through which the sea has worn an arch. In the bay to the S.W. are several rocks like huge ninepins. At 1 mile S. by E. from Brancas Islet is Furada Point, previously described on page 764.

Steen Ground.—A sandy islet has several times been reported as lying in about lat. 32° 20′ or 32° 30′ N., at distances varying from 100 to 200 miles westward of Madeira, one captain placing it in long. 21° 15′ W. It has been searched for in vain, but was again reported in 1860, as an islet with a sandy beach, 1½ mile long East and West, and 2½ cables wide, in the shape of a crescent.

Several banks have been found rising from great depths, between Madeira and the coasts of Europe and Africa; these are treated of hereafter, in the Section on Shoals, Vigias, &c.

The SALVAGES consist of a small island named Ilha Grande or the Great Salvage, another named the Great Piton, a smaller one called the Little Piton, and numerous rocks. They belong to Portugal, being included in the Madeira group, but are uninhabited. Numerous fishing vessels are engaged around these islets during the month of August.

The Great Salvage lies 160 miles South of Funchal, and 92 miles N.E. by N. ½ N. fron the N.E. end of Tenerife. It is 1½ mile in length, N.N.W. and S.S.E., but of very irregular shape, its cliffy shores being indented by several deep rocky inlets, and good landing will be found in the bay on its East side. It is covered with bushes and barilla, and rises into two hills, visible 25 miles in clear weather; *Burt Peak*, on its western side, is 455 ft. high, its summit being in lat. 30° 7′ 31″ N., long. 15° 54′ 20″ W. The island is much frequented by sea-fowl, and it is said that a spring of fresh water rises near the N.E. point. Captain

Mudge, R.N., who, with Captain Vidal, surveyed the Great Salvage in 1820, states that the island is "obviously of volcanic origin, and consists principally of a dark-coloured black rock, the detached parts of which, as well as the whole, exhibit strong marks of fixed magnetic polarity. Even the dust has the same character as the rock itself, and may be gathered up, like steel filings, by means of a bar magnet."

Several small islets and rocks lie scattered around the Great Salvage, to about 1 mile distant, rendering great caution necessary in approaching. It should not be approached within 2 miles, except when bearing between N.W. by N. and N.N.E.[*]

If wishing to anchor here, bring the summit of the island to bear N.W., and steer in, and anchor in 13 fathoms, sand, in the bay on the East side, with the points bearing North and S.S.W.; sheltered from westerly winds. H.M.S. *Prometheus* anchored in 12 fathoms, half a mile off the South coast, with the East point bearing E. by N., and the West extreme N.W. by N. Farther off, the water deepens rapidly, with sharp rocky bottom. Too great care cannot be taken in approaching, as the bank of soundings has not yet been examined.

The Great Piton lies 8½ miles W. by S. ½ S. from the Great Salvage, with an apparently clear passage between. It is 2¾ miles long N.E. ¾ E. and S.W. ¾ W., but narrow; its southern side appears green, but its northern side is barren. *Hart Hill*, near its centre, rises steeply to a height of 140 ft., and is visible 15 miles, from a great distance appearing like a sail; in some respects it is said to resemble the largest of the Needles Rocks at the West end of the Isle of Wight. There are several hummocks on the N.E. and S.W. parts of the island.

The Little Piton, three-quarters of a mile westward of the Great Piton, is about three-quarters of a mile long and very flat; its South end is connected with the South end of the Great Piton by a continuous ledge of rocks. Both the Great and Little Piton are seated upon, and surrounded by, one dangerous rocky bank, which extends 1¾ mile to W. by N. ½ N. from the western side of the Little Piton. *Lecky Reef*, 10 ft. above high water, lies nearly 1 mile N.E. of the Little Piton. It is said that landing on these islets would be attended with great danger, owing to their rocky nature.[*]

Directions.—In navigating between Madeira and the N.E. end of Tenerife, it should be remembered that a direct course passes only

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[*] In 1889 it was reported that a lighthouse was to be erected on the summit of the Great Salvage. Nothing more has been published on the subject since that date.

[†] These islets, like so many others, have been by tradition made the resting place of buried treasure. One credible tale is that in 1804 the crew of a Spanish ship, bound from South America to Cadiz with produce, and about two millions of dollars in chests, rose upon and murdered the captain, off some islands corresponding exactly in description and site with the Salvages. The treasure was carried on shore, and buried in the white sand above high-water mark, in a snug little bay on the South side of the island, and over it was buried also the body of the murdered captain. The vessel afterwards set sail for the West Indies, and was there wrecked, only two of the crew surviving. One of the survivors gave an account of this to an English sailor, which led to an unsuccessful but very perfunctory search by the crew of a vessel of the Royal Navy.

13 miles westward of the Pitons. A sailing vessel bound from Funchal to Tenerife, should keep well to the westward, steering about S. by W. ¾ W., in order to avoid the Salvages and Pitons, which are very dangerous in the night. If prevented from weathering these islets by prevalent westerly and S.W. winds, common in the months of January and February, when a heavy swell may set the ship much to leeward, you may safely bear up and run to leeward of the Great Salvage; only observing that you must cautiously avoid the shoal spots, lying to the northward and eastward of that islet. On their western side the Pitons should not be approached within 4 miles.

Current.—Near these islets the general set is to S.S.E. and S.S.W., the rate varying from a half to 1 mile an hour.

5.—THE CANARY ISLANDS.

This group of islands, belonging to Spain, appears to have been known to the ancients. Strabo refers to them as the *Islands of the Blest*, and Plutarch speaks of them as the *Fortunate* or *Happy Islands*, containing the *Elysian Fields*. Pliny states that the island of *Canaria* took its name from the numerous dogs (Lat. *canis*) owned by the natives, and from hence the islands as a group have received their modern designation.

After the destruction of the Roman Empire, the knowledge of these islands remained buried in oblivion till the thirteenth or fourteenth centuries. In 1341, three vessels sailed from Lisbon, under the command of a Florentine named Angiolino del Tegghia, and visited several of the islands, which they found inhabited. In 1345 an expedition to conquer them was undertaken by Luis de la Cerda, a Castilian prince, but it was repulsed by the bravery of the original inhabitants, the Guanches. After this the islands remained unvisited, except by occasional merchant or pirate vessels, till the beginning of the next century.

In 1402, an expedition under Jean de Béthencourt, a baron of Normandy, took possession of Fuerteventura and Lanzarote, for John, King of Castile, and Alphonso, King of Portugal, who granted him the sovereignty, with aid to colonise these and the other islands. Prince Henry of Portugal made several ineffectual attempts to conquer the archipelago, which finally, after much negotiation, was ceded to Spain in 1479 by treaty. The courageous Guanches, in the almost inaccessible rocks of Tenerife (termed *Infierno* or *Hell* by the invaders, from its crater), defied the Spaniards, and were not thoroughly subdued until 1496.*

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* ALEGRANZA, the name of the northern isle, signifies *joyous*; it was given by the first conquerors of the islands, Jean de Béthencourt, and Gadifer de la Salle, being the first point on which they landed. After remaining several days at Graciosa, they decided to take possession of the island of Lanzarote, and were welcomed by *Guadarfra*, sovereign of the Guanches, with the same hospitality that Cortes found in the palace of Montezuma. The shepherd king, who had no other riches than his goats, became the victim of coward treachery, like the sovereign of Mexico!—*Humboldt.*

The Canary Islands lie between lat. 27° 37½′ and 29° 24½′ N., long. 18° 10′ and 13° 25′ W., embracing an extent of 265 miles from Hierro, on the West, to Alegranza, on the East. The seven large islands are inhabited, and besides these there are the three islets of Alegranza, Montaña Clara, and Graciosa, to the North of Lanzarote, and that of Lobos, to the N.E. of Fuerteventura. Their united area is estimated at 3,360 square miles, and at the census in 1887 the population numbered 291,589, Tenerife and Grand Canary together containing about two-thirds of the number. Santa Cruz, in Tenerife, is the nominal capital of the group, but Lás Palmas, in Grand Canary, contains a larger population, and is of greater commercial importance. From Funchal, Madeira, the nearest island of the group is Palma, 230 miles to S.W. by S. ¼ S.

The inhabitants are a peaceable people, mainly of Norman and Spanish origin, the Guanches being entirely extinct before the year 1500, though their mummified remains are still occasionally found.* The productions, entirely agricultural, consist principally of fruit and vegetables, both exported in considerable quantities, grain, wine,† sugar, cochineal,‡ and tobacco. Orchilla is also abundant. There is a great difference between the N.W. and S.E. sides of each island, the former being covered with vegetation, often very luxuriant, while on the S.E. are dry and arid regions, being more exposed to the sun and the desiccating winds from the African deserts. Oxen, sheep, and goats are bred in considerable numbers; also horses, donkeys, and camels. The rabbit is the only wild quadruped, and quail and partridges are the only winged game. The canary-bird is found in the gardens.

The islands are separated by deep channels, and may be divided into two groups, in which the vegetation is essentially different. The two eastern islands, Lanzarote and Fuerteventura, consist of extensive plains and mountains of comparatively little elevation, with very few springs, their appearance and vegetation being similar to that of the adjacent African coast, and here the camel is used as a beast of burden. The other islands to the westward are more elevated and fertile, being watered by a greater number of springs. The great drawback to agriculture is the comparative scarcity of fresh water, and the light rainfall, especially in Fuerteventura and Lanzarote, where severe droughts are sometimes experienced for several years in succession.

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* The history of the islands is very fully described in a work reprinted for the Hakluyt Society, entitled "The Canarian; or Book of the Conquest of the Canaries in 1402, by Messire Jean de Béthencourt, Kt.," composed by Pierre Bontier, monk, and Jean le Verrier, priest. Translated and edited by R. H. Major, F.S.A., 1872.

Among the many interesting books on these islands, to which reference has been made for the description here given, we may mention:—"The History and Description of the Canary Islands," by George Glas, 1764; "Description Physique des Iles Canaries," translated from the German of Leopold von Buch, 1836; "To the Gold Coast for Gold," by R. F. Burton, and V. L. Cameron, 1883, vol. i., pages 109—258; "Tenerife and its Six Satellites," by Olivia M. Stone, 2 vols., 1887; "The Canary Isles," by Charles Edwardes, 1888; "Cinq Années de Séjour aux Iles Canaries," by Dr. R. Verneau, Paris, 1891; and lastly, a very interesting "Report on the Social and Economical Condition of the Canary Islands," by Mr. A. S. Brown, an English resident in Tenerife, 1892.

† The export of wine, once the staple trade of the Canary Islands, is now again reviving, after being almost ruined by the vine disease. In 1804, the export amounted to 48,000 pipes; in 1885, the value of the wine exported was only £4,855; in 1891, it was £16,230.

‡ *Cochineal* was first introduced to these islands from Mexico, in 1825, but the cultivation of this insect dye only began to assume any importance in 1845. Enormous fortunes were made by the growers, its value in 1869 being estimated at £790,000, but the discovery of aniline dyes quickly rendered its growth less profitable; in 1891 the value of that exported was £85,896.

The land of the Canary Islands is generally high, being varied by volcanic mountains, among which the Peak of Tenerife is super-eminent. The inequality of height is, however, so great as to produce differences in the temperature of the different islands. For eight months in the year the summits, excepting those of Lanzarote and Fuerteventura, are covered with snow; yet in the valleys, and on the shores, the cold is seldom so great as to render fires necessary. A great proportion of the surface of the islands is covered with lava, calcined stones, and ashes, formerly emitted by volcanos, the remains of which are still visible in all the islands, and some of them, among which is the Peak of Tenerife, are not yet entirely extinguished.

The bank of soundings around each island is very narrow, as a rule, and the shores generally precipitous, with a few sandy beaches and coves, the latter being known as ports, though vessels can only safely anchor in them during the fine season, the water being deep. The best are those of La Luz, Grand Canary, and Santa Cruz, Tenerife, and moles are being constructed to render these more secure.

Weighing from any of the exposed anchorages is always difficult and often dangerous for a sailing vessel, and it is advisable only to attempt it when the land-breeze is blowing.

The ports open to commerce are Santa Cruz and Orotava, in Tenerife; Las Palmas, Grand Canary; Santa Cruz, Palma; Arrecife and Port Naos, in Lanzarote; Port Cabras, Fuerteventura; San Sebastian, Gomera; and Valverde, Hierro.

The *Port Charges* are as follow, but pilotage is not compulsory on vessels anchoring outside the harbours. Pilotage, 30 pesetas, on entrance and departure, and 50 per cent. more at night. Clearance, 16¼ pesetas. Health Certificate, 15 pesetas; with small charges for stamps on manifests, &c. On every ton (1,000 kilogrammes) of goods landed the charges are: 0·25 peseta on coal; goods from Europe, 1 peseta; from Spain or Spanish West Indies, 0·75 peseta; from other ports, 2·50 pesetas. Goods exported: 0·25 on coal; goods to Europe, 1 peseta; to Spain or Spanish West Indies, 0·50 peseta; to other ports, 2 pesetas. There is also a small charge on each passenger landing or embarking. There are no dues on vessels calling for coal, water, or provisions.

Money, &c.—The coinage is Spanish silver; the *Peseta*, of 100 *Centimos*, is the unit of value, being equal to about 1 franc or 10*d.*, and 5 pesetas make 1 Spanish *Dollar*. The *Quintal*, of 100 Spanish pounds, equals 101·48 lbs. av.; the *Kilogramme* is 2·2046 lbs. av.; and the *Ton* is 1,000 kilogrammes. The *Fanega* equals 106 to 110 lbs.

The trade of the islands consists entirely in the export of agricultural produce, valued at £267,856 in 1891, cochineal representing £85,896, fruit and vegetables £76,068, and the remainder spirit, wine, almonds, &c. The imports were valued at £665,302, including large quantities of coal for the coaling stations at Santa Cruz and Las Palmas. Several lines of steamers call regularly at these ports, and in 1888 a service of steamers was inaugurated among the islands. There is telegraphic cable connection with Cadiz, Senegal, and Brasil, with subsidiary cables connecting Palma, Tenerife, Grand Canary, and Lanzarote.

The Climate of the Canary Islands, though warm, is generally healthy, being situated near the northern limit of the N.E. Trade Wind. The ordinary summer mid-day temperature, in towns by the sea, averages about 82° F., though it sometimes rises higher. In winter the mean temperature averages between 65° and 67°, seldom falling lower, though colder in the higher lands; snow lies on the peaks for several months of the year. The annual rainfall on the coast of the western group averages only between 8 and 12 inches, falling chiefly in November and December. Owing to this dryness, the climate is considered very suitable for pulmonary complaints, and good hotels have recently been established on Grand Canary, Tenerife, and Palma, resorted to by numerous visitors during the winter months.

Winds.—The prevailing winds among the islands are from North to N.E., but from November to January short but violent gales from S.E. are sometimes experienced, generally bringing rain and thick fog, and foretold by a swell coming in two or three hours in advance; at this season the only safe anchorage is that off Las Palmas. During the same period, gales are also experienced between S.W. and N.W. Southerly winds are sometimes felt, bringing a dry suffocating heat similar to the African Harmattan. In the principal bays there are regular land and sea breezes, though the former never extends far from the shore. When the N.E. wind blows very fresh, a wind from the opposite quarter is often found near to leeward of each island, known as the *Embata.*

The barometer is here very sensitive, rising before winds from the East, and falling before West and S.W. winds. An easterly wind brings thick weather, and when it blows strong is called the *Brisa Parda.*

Calms *of the Canary Islands.*—With a steady N.E. Trade blowing, its current is stopped or diverted by the mountains, and in this way a belt of calms and eddy-winds is formed to leeward of each island. This belt generally extends 30 miles to leeward of Palma, 15 miles from Tenerife, and 25 miles from Grand Canary, though these distances are sometimes greatly exceeded, reaching 60 or 70 miles to the S.W.

"I have," says Captain George Glas, "been frequently in all the calms of the islands, excepting those of Palma; and, from my experience of them, I may venture to say, that it is extremely dangerous for small vessels, or open boats, to venture within them when the wind blows hard without. The sea here, not moving forward in the same direction with the sea without, but being, as it were, stagnant, or at rest, resists the waves that fall in upon it from without; and this resistance causes them to break just in the same manner as the billows break upon the seashore, but with less violence, on account of the different nature of the resistance. This breaking of the waves is only on the very verge of, or just entering into, the calms; for within them the water is smooth and pleasant.

"Upon first coming into the calms, the waves may be seen foaming and boiling like a pot, and breaking in all directions. When a vessel comes amongst them, she is shaken and beaten by the waves, on all sides, in such a manner, that one would imagine that she could not withstand their force; however, this confusion does not last long. The best way to manage a sailing ship entering the calms is immediately to haul up the courses, and diligently attend the braces, to catch every puff of wind that offers, in order to impel the ship into them as soon as possible. The crew must not think it strange to be obliged to brace about the yards every two or three minutes, according as the wind veers and hauls; but after a ship is once fairly into the calms, she will either find a dead calm and smooth water, or a pleasant and constant breeze at South or S.W., according as the wind blows without, to which this eddy-wind, as it may be called, always blows in an opposite direction."

Currents.—Between Madeira and the Canary Islands, West of the meridian of Madeira the current sets to S.S.W., and to the East of it S.S.E. and sometimes S.E. South of the Canaries it generally runs South to S.S.W., and to westward from South to S.W. The velocity averages from 12 to 18 miles in the 24 hours. With regard to this subject, Captain Beechey, in his narrative of the voyage of the *Blossom*, observes:—"As I purposed touching at Santa Cruz we immediately hauled up for the land, and it was a fortunate circumstance that we did so; for so strong a current set to the southward during the night, that, had we trusted to our reckoning, the port would have been passed, and there would have been much difficulty in regaining it. I mention this circumstance with a view of bringing into notice the great southerly set that usually attends the passage of ships from Cape Finisterre southward. From this cape to Point Naga, our error in that direction, or more correctly *S.* 33° *W.* (*true*), was not less than 90 miles."

The flood tide comes from the S.W. and South, rising from 11 to 13 ft. at springs.

The islands were carefully surveyed by Captain Vidal, and Lieut. Arlett, R.N., during the years 1834—1838, and their survey has stood the test of more recent examinations. All the channels between the islands are clear and safe, but sailing vessels passing without wishing to call are recommended to use the channel westward of Gomera, the calm belt here not being so extensive as to leeward of the larger islands. Coming from the southward with a foul wind, a vessel should pass to westward of the whole group.

LANZAROTE, the easternmost island of the Canaries, is 32 miles in length E.N.E. and W.S.W., and its central part is 10½ miles in breadth. Its area is 380 square miles, and in 1887 the population amounted to 16,409. From seaward it appears black, rocky, treeless, and barren, being composed of volcanic materials, but there is a considerable area under cultivation, the chief productions being chick-peas, onions, barley, wine, wheat, maize, tomatos, fruit, &c. These are entirely dependent upon rain for irrigation, the water being stored in tanks, and in some years disastrous droughts are experienced, when the inhabitants are forced to leave the island in large numbers. The grapes and other fruit are of excellent quality, and the wine is said to be very superior to that of the other islands. Camels are used as beasts of burden, on account of the scarcity of water.

Lanzarote contains numerous volcanic peaks and mountains, with intervening deserts of lava and sand, among which are patches of cultivable land. *Monte Corona*, an extinct crater, rises to an elevation of 1,940 ft., near the northern end of the island. At 5 miles S.W. of it is *Monte Famara*, the highest land, attaining an altitude of 2,244 ft., and crowned with a ruined church. At 3 miles S.W. ½ S. from this is the *Castle of Santa Barbara*, on the summit of an isolated peak, close to the N.W. of which is the town of *Teguise*. In the western part of the island is an assemblage of peaks called the *Montañas del Fuego*, which were last in eruption in 1824, and the surface is still very hot in places. To the South of these is a mountainous ridge, extending from *Monte Blanca*, elevated 1,959 ft., abreast of Arrecife, to *Monte de la Hacha Grande*, 1,860 ft., in the southern part of the island.

The shores of Lanzarote are very irregular in outline, and much lower on the eastern than on the western side, and in some parts fronted by rocks. The bank of soundings is very narrow along its western side, and too deep for anchorage. From Peñedo Point it widens out to 6½ miles to the 100-fathoms line, and embraces the islands to the northward. Vessels can anchor along the eastern coast, but the water is often very deep close to the shore. Port Naos and Rio Strait are the only sheltered harbours.

Farion Point, the northern extremity of Lanzarote, is a low rocky projection, with two remarkable pinnacle rocks off it, composed of black vitrified matter, and in shape resembling the Needles at the western extremity of the Isle of Wight. Hence a range of stupendous basaltic cliffs extends 7 miles in a S.W. direction to the base of Monte Famara. At the foot of the cliffs is a narrow strip of low land, with some salt-works, and a small stone pier, where boats can land. The Rio, the strait dividing Graciosa Island from Lanzarote, is described hereafter.

All the western coast of Lanzarote is high and cliffy, uninhabited and almost inaccessible, with the exception of a cove, called *Januvio*, once a harbour for small vessels, but converted into a salt-water lake by an eruption in the year 1765. This is situated 5 miles from Pechiguera Point.

Pechiguera Point, the S.W. extreme of Lanzarote, is cliffy, with rocks around it, and at 1¼-mile E.N.E. of it is *Monte Roja*, 680 ft. high, which appears like an island from a distance, being situated on a wide plain.

The Lighthouse on Pechiguera Point is a gray conical tower, 31 ft. high, showing a *fixed bright* light, elevated 51 ft. above high water, and visible 12 miles.

Papagayo Point is 4¾ miles S.E. by E. ½ E. from Pechiguera Point, the coast forming a bight, in the eastern part of which fishermen anchor in 9 to 13 fathoms, sand. Papagayo Point is a red bluff, with a reef extending South of it, and at 1½ mile to N.W. by N. is *Aguila* or *Rubicon Tower*, built by the early Spanish invaders. Eastward of this is the hut of the ferryman across Bocayna Strait. It has been proposed to establish a fishing station and salt-works on this coast.

At 3 miles N.E. by E. ½ E. from Papagayo Point is *Gorda Point*, and vessels can anchor about half a mile off the coast between, in from 12 to 22 fathoms, good holding ground. *Avila Bay* is the bight between Gorda Point and the village of *Tiñosa*, 4¾ miles to E. by N. ½ N., and in its southern part there is anchorage in 7 to 16 fathoms, abreast the Monte de la Hacha Grande, sheltered from winds between West and N.E. At 1 mile S.E. ½ E. from Tiñosa is *Tiñosa Reef*, and between this and Arrecife, 6 miles to E.N.E., the coast consists of low sandy beaches, separated by rocky points, and *Lima Reef* lines the coast about midway between. Abreast of this, Monte Blanca is seen rising steeply to an elevation of 1,959 feet.

Arrecife, the chief town of Lanzarote, lies close to the sea, the plain on which it is situated being surrounded by hills, and behind the town are numerous windmills. It contains about 2,700 inhabitants, and many of the houses are large and well built, with wide streets. Many of the people are engaged in the fishery on the opposite coast of Africa, which gives employment to 400 or 500 men from this island alone, and the rest of the trade consists in the export of agricultural produce to Grand Canary in good seasons. Water and provisions cannot be depended on, but small stores of coal are kept here for the island steamers and the North-West African Company.

Fronting the town and the coast to the N.E. are several low rocky islets, forming the small harbours of Port Arrecife and Port Naos between, for which reliable pilots are always available, and there is a small compulsory charge for their services.

Port Arrecife, or *Cavallos*, is formed between *Quemado Islet* on the West, and the larger *San Gabriel Islet* on the East, off the western part of the town, with which the latter islet is connected by a bridge. The entrance is only 130 yards wide, with depths of 3 to 9 ft. in it at low water, and it can only be used by coasters. There is a convenient mole for landing. Large vessels anchor in the roadstead, in 17 to 30 fathoms, 2 or 3 cables South of the entrance, taking care to avoid rocky ground; they must put to sea should the wind come on from the southward.

Near the northern end of San Gabriel Islet is the old square stone *Castle of San Gabriel*, and between this and *Francés Islet* are two small islets separating the shallow outer port of *Juan Rejon* from the still shallower *Estila Basin*. From the latter a narrow passage leads to the inner sheltered basin of *San Ginés*, where coasters winter in safety, but they can only get in at high water. There is also another narrow passage in, leading northward of *Perejil Kay* and Francés Islet from Port Naos.

Port Naos is the small but secure harbour N.E. of Francés Islet, being protected from seaward by *Cruces Islet*, and the rocky reef extending N.E. of it. It is much resorted to by coasters during the winter, who lie here secure from all winds and weather, in water as smooth as a mill-pond. It has also been much frequented by large vessels, in need of cleaning or repairs, and here are the coal-stores, near the North end of Cruces Islet. It is approached either from the N.E. or S.W., and has depths of 3½ to 5 fathoms in it at low water, sand and mud bottom, but the available space is very limited.

Boca de San José, the N.E. entrance, is about two-thirds of a cable wide, and passes between the conspicuous fortress of San José and the N.E. end of Cruces Islet reef. Two *beacons* to the West of Fort San José in line, bearing N.W., lead to the entrance, in which the depth appears to be about 18 ft. at low water.

Boca del Perejil, the S.W. entrance, is more used, though shallower, and is narrow, passing between the foul ground extending N.E. from Francés Islet and S.W. from Cruces Islet. The depth in it is reported to be 12 ft. at low water, and a pilot is indispensable for a stranger, as also for the Boca de San José.

Lights.—On the coast to the West of Cruces Islet are *two white beacons*, 20 ft. high, and 122 yards apart, on which *fixed lights*, visible 6 miles, are shown at night; the outer one, *bright*, is elevated 35 ft., and the inner one, *red*, 47 feet. In 1893, a sunken rock was found in the fairway, with the beacons in line bearing N.W. by N. ¾ N., to avoid which the rear beacon (*red* light) must be kept slightly open North of the front beacon (*bright* light).

It is high water, in Port Naos, on full and change, at 1^h; springs rise about 9 feet.

Large vessels anchor off Port Naos, in 18 to 21 fathoms, with the three windmills close East of the town appearing over the S.W. end of Cruces Islet. In 1881, H.M.S. *Espiègle* anchored in 16½ fathoms, half a mile eastward of the Boca del Perejil, with Fort San Gabriel bearing West; the S.E. light beacon, N.W. by W. ¾ W.; and the N.E. extreme of Cruces Island, N.W. ¾ N., apparently coral bottom. This berth was found convenient for receiving coal in lighters from the coal-stores.

From Fort San José the coast trends in a curve, first E. by N. and then N.E. ½ N., 9 miles, to *Pasito Point*, and is in places fringed with rocks. Between this point and Mugeres Point, 4½ miles to N.E. by N., is *Arrieta Bay*, with a village at its head, off which vessels can anchor in 11 to 15 fathoms, but completely exposed to easterly winds. From Mugeres Point the coast trends 3 miles N.N.E., and then 3 miles N.W. by N., to Farion Point (page 781), and is fronted by rocks and foul ground all along. At 1½ mile south-eastward of Farion Point this foul ground extends nearly half a mile off, and is known as Orsola Reef.

Rio Strait, the passage separating Graciosa Island from the northern end of Lanzarote, is 6 cables wide in its narrowest part, and here, on the bank connecting the two islands, the least depth in the channel is from 4 to 4½ fathoms at low water. On the S.W. part of this bank are some patches of 2¾ and 3 fathoms, which will be avoided by passing nearer to Graciosa. This strait forms a secure anchorage for repairing or refitting even large vessels, which have here been careened in the summer season, but there are no resources nor any inhabitants. Indifferent water may be obtained by digging in the sand, at the foot of the Lanzarote cliffs. Fish, also, is abundant and good. The extreme difficulty of communication with Lanzarote presents an insuperable obstacle to its being resorted to as a harbour for trade. The basaltic cliffs rise almost perpendicularly to the height of 1,500 ft., and can be climbed only by a narrow path which winds along the face of the precipice; halfway up the cliff is a spring of fresh water, but rendered useless from its situation, except to a few goatherds. The fishermen have here constructed a small stone pier, where boats can land under safe shelter; on the Graciosa side there is a small bay where landing can always be effected, and here are some spacious sheds, built for the purposes of a fishery.

Captain Glas remarks, that if a smooth place to lie in, while the Trade Wind blows, be required in Rio Strait, a ship coming from the eastward must run a good way in, and double a shallow point, on the starboard hand, taking care to give it a good berth; and this is easily done by approaching no nearer than in 4 fathoms; when past it, edge toward Graciosa, and anchor in any convenient depth, for it shoalens gradually toward the shore, close to which there is 2 fathoms. Here, however, the water is not so smooth as at Puerto de Naos, especially if the Trade Wind happens to blow hard from the East, which sends in a swell that makes it troublesome, if not impossible, to careen a ship properly. But the wind here does not often blow from that quarter, those winds which most prevail being from North and N.N.E. In mooring here, great care must be taken to have a good anchor, with a large scope of cable toward Lanzarote; for, in East and S.E. winds, heavy gusts or squalls come from the high land of that isle. In the winter, the wind sometimes blows strongly from the S.W.; then it is necessary to weigh, and run back to the eastward, round the shallow point before mentioned, until the ship be sheltered from that wind, and there anchor.

East Rock, or *Roca del Este*, which lies in the approach to Rio Strait from the eastward, is the craggy summit of an extinct volcano, and, being steep-to, is very dangerous at night. It is of no great elevation above the sea, and lies 7½ miles E. ½ S. from Farion Point, and 11 miles S.E. by S. ½ S. from Alegranza Island lighthouse.

GRACIOSA ISLAND is a flat sandy island, 5 miles in length, N.E. and S.W., and 2½ miles wide at its N.E. end, and its shores are surrounded by rocks. *Monte de Pedro Barbo* rises to a height of 873 ft. near its centre, and at its S.W. end is *Monte Amarilla*, another volcanic hill 540 ft. high. The island is destitute of water, but in favourable seasons cattle are sent over from Lanzarote for the pasturage.

Montana Clara Island, separated from the North end of Graciosa by a deep channel 1 mile wide, is 1 mile long, N.E. and S.W., sloping to the S.W. from its bold cliffy northern end; its East and S.W. shores are foul. *Infierno* or *West Rock*, 20 ft. high, lies half a mile N.E. of Montaña Clara, with foul ground between; it is covered with volcanic scoriæ, resembling coke, and must be cautiously avoided at night.

ALEGRANZA ISLAND, the northernmost of the Canary Islands, is 5¾ miles N.N.E. of Graciosa, and about 2 miles in diameter; it is composed of bare lava and cinders, the remains of an extinct volcano, and rises at its western end to the height of 940 ft. above the sea. The edge of the crater is well defined, and two-thirds of a mile across; its bottom was cultivated for barilla. The western cliffs are precipitous, and 700 ft. in height. The only landing-place is on the South side, where a cavern extends about 500 paces, slanting from the sea, where it terminates in a little sandy bay; at the entrance the rocks form a natural jetty. Abreast this is the only anchorage, half a mile from shore. A few fishermen reside here, and orchilla also abounds.

The Lighthouse on *Delgada Point*, the western extremity of Alegranza, is a dark gray tower, 49 ft. high, showing a *revolving bright* light, attaining its greatest brilliancy once every half-minute, elevated 57 ft., and visible 13 miles. To the westward it is obscured by the land between S.W. by W. ¼ W. and N.W. by N. ¾ N.

Bocayna Strait, or *Canal de Bocayna*, between Lanzarote and Fuerteventura, is 6 miles in width, but is contracted to 4¾ miles by Lobos Islet, on its S.E. side. Vessels can anchor anywhere in its eastern half, in depths of 17 to 22 fathoms, and over, bottom of sand, shells, or coral. By night, this strait is well marked by the lighthouses on Lobos Islet, Tostan Point, and Pechiguera Point. Ships of the largest size can safely work through this channel, should the wind be contrary, but beware of approaching too closely to the foul ground on either side.

Captain Glas remarks that when a vessel comes from the eastward, with the Trade Wind, and is passing through the Bocayna to the westward, so soon as she brings a high hill on Lanzarote directly to windward of her, she will be becalmed, and soon have the wind at S.W. Should this happen, make short tacks until you obtain the Trade again, or a constant northerly wind, the first puff of which will come from West or W.N.W. So soon as this is perceived, you must not stand more to the northward, otherwise you will immediately lose it again, but must steer towards Lobos; for the nearer you approach this isle the more will you have the wind; so that, before you are two-thirds over, you will meet with a steady wind at North or N.N.E.

When there is a great westerly swell hereabout, the sea breaks horribly on the rocks at the N.W. end of Lobos. Captain Glas affirms that he saw breakers there nearly 60 ft. high; of which, were one to strike the strongest ship, she would be staved to pieces in a moment. "When I first saw," says Captain Glas, "those mighty breakers, our ship had just passed through the channel between Fuertaventura and Lobos; we had a fine brisk Trade Wind at N.N.E., and although there were no less than 10 fathoms of water when we came into the westerly swell, yet we trembled lest the waves should have broken, and thought ourselves happy when we got out of soundings. We heard the noise of these breakers, like distant thunder, after we were past them 6 or 7 leagues."

Lobos Island, nearly 2 miles in length, N.E. and S.W., takes its name from the seals which frequent it at certain seasons. It is destitute of fresh water, and is covered with a number of conical hillocks, the highest elevated 360 feet. Its shores are abrupt, and fronted with rocks, reaching 3 cables off the N.W. point, but on the S.W. side there is a sandy beach. On its western side is a crater, open to the sea, called the *Caleta del Palo.* There is a narrow channel, with 6 fathoms least water, between the shoals lining the S.W. side of Lobos and those lining the N.E. side of Fuerteventura. In the eastern part of this channel there is a good roadstead, where vessels can anchor in 6 fathoms, bringing the S.E. point of Lobos to bear nearly N.E. by N., and anchor halfway between it and Fuerteventura, or rather nearer to the latter. Although this road seems to be open and exposed, yet it is very safe with the Trade Wind, for the water is smooth, and the ground everywhere clean, being a fine sandy bottom. Abreast the road, on Fuerteventura, is a well of good water, of easy access.

The Lighthouse on *Martiño Point*, the North point of Lobos Island, is a dark yellow tower, 21 ft. high, showing a *fixed red* light, elevated 95 ft., and visible 9 miles. It is obscured by land to the S.W., between W. by N. ¼ N. and S. by W. ¼ W.

FUERTEVENTURA is the second in point of size of the Canary group, but is of little commercial importance. It is 57½ miles in length, between Gorda Point, on the N.E., and Jandia Point, on the S.W., its greatest breadth being 16 miles, and its area 797 square miles. It is mountainous, attaining an elevation of 2,240 ft. at *Mount Muda*, in its northern part. To the southward of Port Cabras, the mountains branch East and West to the sea, thence following the direction of the coast on each side for about 30 miles; again uniting, they encircle an extensive and arid plain. Towards the S.W. the mountains fall abruptly to a low sandy isthmus, named *Matas Blancas*, or *La Pared*, about 5 miles long and 2½ to 3½ miles wide, beyond which the land again rises to a mountainous ridge, its summit, known as the *Monte Jandia*, *Orejas de Asno*, or *Asses' Ears*, being elevated 2,770 feet. This mountain presents the most remarkable features; on the N.W., its face is precipitous, and spurs, or buttresses, diverge from its centre to the N.E., East, and S.E., by which it may be ascended to the frightful ridge on the summit. Thus, from a distance, this elevated ridge appears like a separate island.

The island is chiefly volcanic in its structure, but there are considerable areas of limestone, which is exported to the other islands. Like Lanzarote, however, it is subject to disastrous droughts, though water is to be had by sinking wells. From the summits of the hills, the course of some brackish streams may be traced by the verdure they impart. Although the general feature of Fuerteventura is extreme barrenness, still there are many spots of great fertility; the most conspicuous of these is the valley of *Oliva*, toward the North end, where there is a village of the same name. This valley is about 15 miles long, and generally from 2 to 3 miles wide. The only two streams of pure water in the island have their rise in the mountain of the Atalaya, or watch-tower; they are husbanded with great care, and irrigate the whole of the valley.

The population of Fuerteventura numbered 10,130, by the census of 1887, scattered in numerous villages and small towns on the plains between the mountains. *Santa Maria de Betancuria* is the nominal capital, but Port Cabras is the only place of trade. There is a paved road across the island, from Cabras to Betancuria, but the other roads are mere tracks following the direction of the valleys, where the ground is less cumbered with stones, and softer to the camels' feet.

The coast of Fuerteventura is generally high and abrupt, but there are many sandy beaches, especially around the mountainous Jandia Peninsula.

In some parts rocks and foul ground line the coast, but all along the East and South coasts, the bank of soundings, as a rule, is very narrow. It is much wider off the western coast, and the 100-fathoms line is found at 12 miles W.S.W. of Jandia Point, dropping suddenly from 50 to 500 fathoms and over.

Jandia Point, the S.W. extremity of Fuerteventura, is a low narrow projection, with a reef extending two-thirds of a mile S.W. by W. from it. *Griego Rock*, near the extremity of this reef, uncovers at low water, and close outside it are depths of 12 to 15 fathoms. The currents in this locality form strong eddies, and a wide berth should be given to this point. Between Jandia Point and *Pesebre Point*, 2¾ miles to N.E. by N., the coast is low and sandy, with numerous rocks off it; foul ground extends half a mile northward of the latter point. *Puerto de la Cruz* is the bight close East of Jandia Point, where vessels can anchor and lie sheltered from northerly winds between N.W. and N.E. In approaching this from the southward, the 100-fathoms line is found at 1¼ mile off shore, suddenly decreasing to 50, 30, 20 fathoms, and under.

The Lighthouse on Jandia Point is a gray tower, 62 ft. high, showing a *revolving bright* light, attaining its greatest brilliancy once every minute, elevated 108 ft., and visible 15 miles; the arc of visibility seaward is comprised between E.S.E. and N.E. by N. ½ N., round by South, West, and North.

The Western Coast of Fuerteventura is not visited by shipping, and the chart sufficiently shows its features. Close to the shore, at 3 miles eastward of Pesebre Point, is *Moro Rock*, high and rocky, and at 4½ miles farther on is the *Islote*, on the sandy beach, at the foot of the precipitous *Monte Jandia*. To the N.E., above the sandhills of *Matas Blancas*, rises *Monte Chilegua* to an elevation of 2,240 ft., with a village between it and the coast. Vessels can anchor off this village in 19 fathoms, 2½ miles from shore, exposed to N.W. winds. At 8½ miles farther on is the small town of *Santa Maria de Betancuria*, about 5 miles inland, situated among the hills.

Tostan Point, the N.W. extremity of Fuerteventura, is surrounded by reefs and shoal water, which extend for three-quarters of a mile off and around it, and break violently in rough weather.

The Lighthouse, on the northern extremity of Tostan Point, is a round tower 23 ft. high, completed in 1894, and is intended to show a *fixed bright* light, elevated 36 ft., and visible 10 miles seaward, over an arc of 216°, comprised between Equinazo Point and 1 mile northward of Marrajo Cove. Near the lighthouse is a small landing pier.

Hence the coast turns to the East, fronted with rocks, and at 7½ miles distant is *Gorda Point*, the low North extremity of the island. To the S.E. of this point is the fishing village of *Corralejo*, and farther on is *Lobos Island*, described on page 785.

Port Cabras, 15 miles to the S.S.W. of Lobos Island, is the only port of the island, but is now of little consequence, the village here only containing about 500 inhabitants, and boats land on the beach. It is an open roadstead, exposed to easterly winds between N.E. and South; from 50 fathoms the depths decrease gradually to the shore, and vessels anchor off the village in 12 to 20 fathoms, sand and shells. From the village, *Mount Muda* bears about N.W. by N.

To the south-westward of Port Cabras, the coast is indented by numerous small bays and coves, but the only one of any note is *Port Tarrajal*, and here the anchorage is indifferent, and the landing bad. At 4 miles eastward of it is *Lantailla Point*, the nearest part of the Canaries to the African coast, here 55 miles distant.

Morro Jable Point, the low southern angle of the Jandia peninsula, must be carefully avoided at night, not bringing Jandia Point light to bear westward of N.W. ¼ W.

GRAN CANARIA, or Grand Canary, 44 miles W. by N. from the S.W. extremity of Fuerteventura, though not the largest, is considered to be the most important island of the Canary group, both with respect to its fertility and commercial resources. It is nearly circular in form, with an average diameter of 25 miles, its area being estimated at 634 square miles. It is very mountainous, with numerous evidences of volcanic action, and from sea appears high in the centre, sloping to the sea in broken and serrated ridges, between which run numerous streams, a remarkable contrast with the islands previously described. *Los Pexos*, the central mountain range, attain an elevation of 6,400 ft., forming an immense ravine on their N.E. side. There are three mineral springs in Grand Canary.

Being better watered than any other island of the group, Grand Canary is consequently more wooded and fertile, and exports large quantities of fine fruit, vegetables, and wine. The palm, olive, banana, and other subtropical trees and plants flourish in its fruitful valleys, and the vine and sugar-cane are extensively cultivated. It is the granary of the Canarian group, and has, in some districts, two wheat harvests in the year—one in February, the other in June. Cochineal is largely produced, and maize and tobacco grown. At the census in 1887 the population numbered 95,415, the chief town being Las Palmas, on the N.E. coast.

The coast of Grand Canary is generally very high and bluff, with but few off-lying dangers, and the surrounding bank of soundings affords more anchorages than any of the other islands. In case of need, the chart and lead will prove sufficient guide, but Las Palmas is the only port visited by foreign vessels. The bays on the North and West coasts are usually unsafe during the dry season, being exposed to N.W. winds; and those of the South and East coasts are bad from November to January, being open to the S.E. winds then prevailing.

As before explained, the central mountains of Grand Canary tower so far above the clouds as to stop the current of the prevalent N.E. wind, especially in summer; so that when this wind blows hard on the North side of the mountains, it is either quite calm on the other side, or a gentle breeze blows upon it from the S.W., to the distance of 8 or 9 miles off shore, when the aerial currents again unite. Within this space a westerly current runs about half a mile an hour close inshore, which is advantageous to the coasters.

Isleta Peninsula is a singular projection from the N.E. side of Grand Canary. It is a rugged hilly district, about 2 miles in diameter, and united with the shore by a low and narrow sandy isthmus. Several detached rocks lie around it, and the *Becerro Ridge* extends 4 cables off the N.E. point.

The Lighthouse, standing on the northern and highest hill (787 ft.) of the Isleta Peninsula, is a dark gray tower 31 ft. high, from which the lighthouse on Jandia Point, Fuerteventura, bears N.W. by W. ½ W., distant 48 miles. The light is *fixed bright*, visible 18 miles, varied by a *red flash* every 2 minutes, visible 12 miles, and elevated 817 feet. On another hill, 747 ft. high, nearly 1 mile to S.W. by S., is a watch-tower and *Signal Station.*

Confital Bay, on the N.W. side of the sandy isthmus, is exposed to N.W. winds, but coasters get in between a ledge of rocks and the isthmus, and there lie secure from all winds and weather, and careen or effect repairs, &c. The bay is clean, with depths of 25 fathoms and under, bottom of sand, and with S.E. winds the water is very smooth, and it is then a much frequented anchorage. The telegraph cable from Tenerife is landed here.

Sphinx Head, the eastern extremity of the Isleta, is a cliffy promontory, off which lie two rocks, known as *El Nido* and *El Roque*, nearly a quarter of a mile distant. Two rocks, drying at half-tide, lie 1½ cable off shore, about half a mile S.W. by W. ⅛ W. from El Roque, the southernmost.

Las Palmas, the largest town of the Canaries, contained 20,756 inhabitants at the census in 1887, has a good appearance from seaward, and the tower of the cathedral appears conspicuously above its white buildings. It extends more than 1 mile along the beach, and buildings occupy the slopes of the fortified hills behind it. It is surrounded by a fertile country, and is well supplied with provisions and fresh water, the latter brought by an aqueduct from the interior, and led in pipes to the end of the mole. There is a good market and two hospitals, and the hotel accommodation is satisfactory. Coal can be obtained here and at Puerto de la Luz, in any quantity. The exports consist chiefly of fruit, vegetables, cochineal, wine, &c., the value in 1891 being estimated at £395,355.

In fine weather, the anchorage off Las Palmas is in 13 to 17 fathoms, good holding ground, about half a mile off the shore, but is not recommended, the swell being heavier here than at Puerto de la Luz, and the landing often dangerous. A *fixed red light*, visible 6 miles, is shown near the extremity of the mole.

Puerto de la Luz, the bay on the East side of the Isleta isthmus, affords the best sheltered anchorage of the Canary group, and extensive harbour works are now in progress here. The roadstead has depths of 15 to 12 fathoms, and under, sandy bottom, only exposed to S.E. winds, and they seldom blow so hard as to endanger a ship; they are not experienced between March and November. Vessels coaling lie as near the end of the mole as convenient, but a large vessel coming in at night should anchor in about 15 fathoms, soon after losing sight of Isleta light. A good berth is in 12 fathoms, with the large rock off Sphinx Head bearing about N.E. ¼ N.; Fort Santa Catalina, W. by N., distant two-thirds of a mile; and the lighthouse on Las Palmas mole, S. by W. ½ W. Vessels anchoring must beware of fouling the telegraph cable, which runs off in an E.S.E. direction, at 1¾ cable southward of Fort Santa Catalina. Landing can always be easily effected at the landing steps inside the mole. It is high water here, on full and change, at $0^h\ 52^m$; springs rise 10 feet.

Quarantine Buoy.—In 1893, a *white* mooring buoy, for vessels in quarantine, was lying in 9 fathoms, with the Isleta signal station bearing N.W. ¼ W., and the lazaretto (near San Fernando Battery), W. ¾ S.

The Harbour of La Luz is formed by a substantial mole extending in a S. by W. ¾ W. direction from the Isleta shore, about 1½ cable westward of San Fernando Battery. When finished, this mole will be about 1,500 yards in length; it is approaching completion, the extremity of the works being now in a depth of about 8 fathoms. At about 4 cables northward of the old Castle of Santa Catalina, another mole is being constructed for about 600 yards in an easterly direction, and the area thus enclosed is nearly 300 acres, with depths of 5 to 7 fathoms, and under. Vessels of considerable burden can now lie alongside the wharves for receiving or discharging their cargo, and for coaling purposes. The harbour is connected with Las Palmas by a steam tramway.

Of late years Las Palmas has made great strides as a coaling station, and coal is now stored here in large quantities; there are facilities for putting it on board at the rate of 50 to 60 tons an hour. Other supplies, including good fresh water, are also abundant.

A small *fixed red light*, elevated 23 ft., and visible 6 miles, is shown near the extremity of the mole works.

Vessels wishing to enter the harbour must first obtain a pilot, pilotage being compulsory, and they are always on the look-out. There are signal stations on the Isleta, and on the hill above the town.

In 1894, the port rules required steamers, intending to remain longer than 24 hours within the port, to moor in line, head to the southward, with two stream anchors astern. Those intending to remain only a few hours may lie at single anchor. Sailing vessels, above 500 tons and of not less than 13 ft. draught, may anchor in the port clear of the entrance channel. Those of less tonnage will be berthed alongside the pier, or in a position indicated by the authorities.

Port Gando, the only other harbour of any consequence in Grand Canary, is situated about 10 miles southward of Las Palmas, in the northern angle of *Gando Bay.* Coasters here lie in 7 or 8 fathoms, sheltered from all but southerly winds, and good water and other refreshments are plentiful. In approaching this bay from the northward, *Gando Point* must have a wide berth, as off it lies a dangerous rock, awash at low water, on which several vessels have been wrecked; it lies 6½ cables E. by N. ½ N. from the point, with depths of 5 to 17 fathoms close around it. To pass clear to the East of it, keep the whole of the Isleta peninsula open clear of Las Palmas, and at night the light on Areynaga Point will serve as a guide for avoiding it.

Areynaga Point Lighthouse, about 4½ miles S.W. by S. from Gando Point, is constructed of dark red stone, and shows a *fixed red* light, elevated 154 ft., and visible 10 miles seaward, over an arc of 166°, from about 1 mile eastward of Gando Rock to 1 mile eastward of Tanife Point.

Tanife Point is low, and on the coast to the West of it are the Juan Grande salt-works, and the old castle of *Romeral.* At 8½ miles distant is

Maspalomas Point, a low sandy projection, the southern extremity of Grand Canary. A stream runs into the sea on its western side, westward of which the coast again becomes high and rocky.

Maspalomas Point Lighthouse is a stone tower 187 ft. high, of a bluish gray colour, standing close to the shore, on *Morro Colchas Point,* more than 1 mile W.N.W. of the low point of Maspalomas. It shows a *fixed bright* light, elevated 190 ft., and visible 20 miles seaward, between East and W. by N. ½ N.

The S.W. and West Coasts of Grand Canary are high and cliffy, with but few off-lying rocks, and those close to the shore.*

Sardina Point Lighthouse, on the northern extremity of Grand Canary, is a gray tower 20 ft. high, showing a *fixed bright* light, elevated 105 ft., and visible 12 miles.

TENERIFE, to the N.W. of Grand Canary, is separated from it by a deep channel, 31 miles in width where narrowest. This island, the largest and most remarkable of the Canary group, is of a triangular form, 46¾ miles in its greatest extent N.E. by E. and S.W. by W., by 27 miles at its western end, its N.E. part being a long peninsula of rugged volcanic mountains, varying from 3½ to 9 miles in width; its area amounts to 919 square miles. The central part is occupied by a lofty mountainous ridge, which slopes rapidly towards the coast on either side, and culminates in the famous peak, called, both by the ancient and present inhabitants, the *Peak of Teyde,* the summit of which is 12,180 ft. above the sea, or more than 2¼ statute miles, the most singular object, perhaps, of its kind in the northern hemisphere.

Tenerife, being much less bountifully supplied with water than Grand Canary, is consequently less wooded and fertile, and not so important in a commercial sense. At the census in 1887, the population numbered 109,993, mostly occupied in fishing and agriculture. Santa Cruz is the principal town. The productions are much the same as those of Grand Canary.

From seaward, large areas present to the view the appearance of complete desolation, consisting of fields of lava, broken and irregular like half-consumed coke. The shores are mostly bold and cliffy, with but few off-lying rocks and reefs, and the bank of soundings is very narrow. As around Grand Canary, there are numerous small open bays, but the only ports frequented by foreign shipping are Santa Cruz and Orotava.

On coming toward the island in clear weather, the Peak may be clearly discerned at a great distance. It first appears like a thin blue vapour or smoke, very little darker than the sky; at a farther distance the shade disappears, and is not distinguishable from the azure of the firmament. Before you lose sight of this towering mountain, it seems at a considerable height above the horizon, although all the rest of the island, the upper part of which is exceedingly high, is sunk beneath the horizon. But, in general, in sailing toward Tenerife, when the Trade Wind blows, the island appears as a haziness of the sky, or as a cloud, till within the distance of 18 or 20 miles, and then the headlands are very conspicuous.

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* The old Tenerife pilots asserted that a rock, with only 12 ft. over it, lay 7½ miles to the W.N.W. of *Aldea Point,* the N.W. point of Grand Canary, and that the sea broke on it in rough weather. Its precise situation was unknown, and its existence is very doubtful. In the old charts, another sunken rock was laid down in the southern part of the channel between Tenerife and Grand Canary, about 24 miles S.E. by E. from Roxa Point, the S.E. point of Tenerife, and 15 miles W. ½ S. from Aldea Point.

It is said that, in very clear weather, the Peak may be seen at a distance of 150 miles, and the natives say it has then been seen from the Bocayna, between Lanzarote and Fuerteventura, or about that distance. Others have reported seeing it at vastly greater distances, but it is considered that this may have been due to the effects of *mirage*. The winter months are the most favourable for seeing the Peak when far distant, and Baron Humboldt says:—"It may be admitted, in general, that the Peak of Tenerife is seldom seen at a great distance in the warm and dry months of July and August; and that, on the contrary, it is seen at very extraordinary distances in the months of January and February, when the sky is slightly covered, and immediately after a heavy rain, or a few hours before it falls."*

"The Peak of Tenerife is probably the most striking monument of nature in the world; for, though Chimborazo (in South America) soars to the height of 22,000 ft., and the Himalayan Dewalgiri (in Asia) to the astonishing height of 27,000 ft., while Tenerife is but 12,176 ft., yet the latter, by its rising directly from the level of the sea, is seen more conspicuously, and stands at a more magnificent elevation. The view from the summit is unspeakably grand. On the top of this vast pyramid of basalt is a crater, 40 yards deep, from which vapour continually ascends, and specimens of finely crystallized sulphur are gathered round its lips. From the summit, when the sky is unobscured, the whole island is seen like a model. Rising around it, at a distance, are seen the Canaries, glittering on the horizon, their peaks and pinnacles coloured by every change of day. At favourable times, Madeira and the African coast are visible."—*Captain Alexander*, 1837.

Baron Humboldt, who ascended to the summit, considered that the crater of the cone has not been active for ages, the eruptions of more modern times having been from the sides of the mountain. The last recorded eruption was in 1798, at the foot of Mount Chahorra, but the cone still gives off hot sulphurous vapours. The cone is very small in proportion to the size of the mountain, it having a height of only 537 feet. The lower part of the island is composed of basalt and other igneous rocks of ancient formation, and is separated from the more recent lavas, and the products of the present volcano, by strata of tufa, puzzolana, and clay.

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* Some very interesting particulars of the Peak, with photographic views, are given by Professor C. Piazzi Smyth, F.R.S., in his book entitled "Tenerife; an Astronomer's Experiment, or Specialties of a Residence above the Clouds," 1858. Professor Smyth and a party of scientific men went in Mr. Robert Stephenson's yacht, the *Titania*, to Tenerife, in June and July, 1856, and carried their instruments up the flanks of the Peak to Guajara, 8,903 ft. above the sea. The results of these observations were very remarkable, and the expectation was fulfilled, that the astronomical objects would be seen with much greater clearness and brilliancy when the lower strata of cloud and vapour were passed.

Some accounts of later ascents are given in the works enumerated in the note on page 777. June, July, and August are the best months for making the ascent, the best route being from Orotava, spending one night at a shelter on the mountain. Horses can be ridden to within a short distance of the cone.

Anaga Islets are two black rocks about 60 ft. high, lying off the northern extremity of Tenerife, the outer one being in lat. 28° 36′ 30″ N., long. 16° 8′ 35″ W. The southern one is connected with the coast by a reef; otherwise they are steep-to. *Fuera Rock* is a dangerous pinnacle, scarcely visible, one-third of a mile W. by N. from the North point of the outer rock.

Roque Bermejo Point Lighthouse, about 1 mile S.E. of the inner Anaga Rock, is a gray tower 39 ft. high, showing a *fixed bright* light, varied by a *bright flash* every 3 minutes, elevated 810 ft., and visible 35 miles in clear weather. It illuminates an arc seaward between Anaga Rocks and Drago Point; the latter lying about half-way to Anaga Point.

Roque Bermejo Islet, 3¾ cables S.E. ¼ E. from the lighthouse, is connected with the shore by a reef dry at low water.

Anaga Point, the eastern extremity of Tenerife, has a few rocks around it, and on its northern part, at 1¾ mile S. by E. from Roque Bermejo lighthouse, is a high conical rock close to the shore, called the *Mancha Blanca*, though it usually appears of a dark colour from seaward. *Mancha Rock*, 3½ cables E. by S. from the Mancha Blanca, is a dangerous patch with 14 ft. water over it, only breaking in heavy weather,* with deep water around it. Passing vessels are recommended to give this coast a berth of 2 miles.

Antequerra Point, 1⅓ mile S.W. by S. ½ S. from the Mancha Blanca, is a long narrow projection, forming a bluff point about 700 ft. high. Upon the heights above is a semaphore *Signal Station*. In passing along the coast hence to Santa Cruz, 9 miles W. by S., the land appears rugged and mountainous.

Santa Cruz, the capital of the Canary Islands, contained 19,722 inhabitants at the census of 1887, and the chief government authorities reside here. Its aspect is not inviting, and in summer the heat is excessive. On a narrow sandy tract, houses of dazzling whiteness, with flat roofs, appear to be stuck against a wall of black perpendicular rocks, devoid of vegetation. A fine mole, built of freestone, the public walk, planted with poplars, and the towers of the churches, are the only objects which break the sameness of the landscape. There is a sailor's hospital here. Provisions are abundant, and good water is supplied from a pipe at the mole. Small repairs can be executed here, and coal is stored in large quantities for the use of steamers, being placed on board by means of lighters.

The town is defended by several forts and batteries. *Paso Alto Battery*, the northernmost, is now in ruins, but being useful as a mark for the anchorage, its position is marked by a white pyramid *beacon*. About 250 yards S.W. of this is *Fort San Miguel*, and at 400 yards farther on is a new fort, named *Ciudadela*, with its walls painted red, forming a good mark. *Fort Almeida*, a short distance farther on, is conspicuous, having red casemates, with white walls above and below; at 220 yards N.N.W. of it is a conical-shaped building. There are several smaller forts to the S.W. of the town, the most distant being 1 mile from the mole, and here there is landing in fine weather. At 2½ cables East of this is the *Lazaretto*.

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* A rock, probably the same, with 18 ft. water over it, has been reported to lie about 1 mile farther off, on the same bearing. It was announced by the officers of the mail steamer *Cleopatra*, in December, 1859.

Santa Cruz is a regular port of call for several lines of African and South American steamers, thus placing it in constant communication with the chief ports of Europe, and besides this there is telegraphic communication (page 779). Its trade consists almost entirely in the coaling of steamers, and the export of fruit and vegetables, cochineal, and wine. In 1892, the value of the exports was estimated at £438,941, and in that year 843 vessels visited the port, with a total tonnage of 1,214,290.

Harbour.—A wide mole projects to the eastward, off the middle of the town, and this is being prolonged in a N.E. direction, the extremity of the works now being in a depth of 10 fathoms, and marked by a *buoy*. One vessel can lie alongside, but when completed, the mole will be about 1,000 yards in length. A shorter mole is constructed in a S.E. direction, close S.W. of Fort San Miguel, so that when the works are finished, the harbour will have a large area, with depths decreasing gradually from 10 fathoms, where vessels will lie sheltered from all winds. Boats can always land under shelter of the mole.

Lights.—On the angle of the inner part of the mole is a dark tower 21 ft. high, showing a *fixed bright* light, elevated 38 ft., and visible 9 miles. A *fixed red* light, elevated 26 ft., is also shown near the extremity of the works.

Although pilotage is not obligatory, vessels anchoring are recommended to employ a pilot; they are always on the look-out, and the charge is small.

The bank of soundings is very narrow off Santa Cruz, the 100-fathoms line being found 3 cables off Fort San Juan, but widening to 7½ cables abreast Paso Alto Battery, the depths decreasing quickly to 50, 40, and 30 fathoms, and then more gradually to the shore. Consequently, vessels coming in must be prepared to anchor immediately the lead shows the required depth. Sailing vessels find it difficult, and often dangerous, to get under way with winds from seaward, and it is advisable to wait till they moderate, which they usually do at night.*

The roadstead is only protected from winds between S.W. and N.N.E., round by North, but if moored with good cables and anchors, vessels may here lie securely in all winds, although exposed and open to those which blow from the N.E., East, and S.E.; however, it is not above once in the space of four or five years that these winds blow so hard as to cause any considerable damage. During November and December, if signs of a S.E. gale are noticed, before it is felt, such as a S.E. sea rolling in, sailing vessels should get under weigh, and run for shelter to the N.W. side of the island, where they will find it calm, and may anchor to await a change. There is generally a swell setting in, but at such times, the surf frequently beats on the Santa Cruz shore with great violence, and for several days together.

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* Mooring buoys have been placed in the roadstead, for the use of vessels getting under way, but their positions are uncertain.

Winds.—The only time when this roadstead can be said to be dangerous, is stated to be between the middle of November and the middle of January, when heavy gales from S.E. to S.W. are sometimes experienced. The Trade Wind usually sets in about the end of March, and lasts till October, varying between N.N.E. and East, but usually N.E., and sending in a heavy sea. Unless blowing very fresh, it usually falls calm about sunset, and at night there is a light land breeze.

Lieut. Church, of H.M.S. *Ætna*, makes the following observations on this anchorage :—" Whilst surveying the Canary Islands in the *Ætna*, we had, of course, considerable experience of Santa Cruz, and had no reason to consider it an unsafe anchorage. During the very many times that the *Ætna* was there, in only one instance did we experience a gale from the south-eastward. Most of the shipping slipped at the commencement, and got into the offing ; but we remained at our anchors, and rode it out well. Although a heavy sea tumbled in, there was much less strain on the cables than might have been expected, arising, as it appeared to us, from an offset, which, together with there being a great uphill drag for the anchor, diminishes the chance of driving."

The usual anchorage ground extends from abreast the centre of the town to abreast Paso Alto Battery, a distance of about three-quarters of a mile. The 5-fathoms line runs from 1½ to 2 cables off shore, thence deepening gradually to 15 and 20 fathoms at 2½ to 4 cables off, over a bottom of sand or clay, good holding ground. Vessels can thus take up their anchorage as convenient, allowing a large scope of cable, but merchantmen usually lie with the church tower of San Francisco (having a cupola), near the centre of the town, appearing over the southern part of the mole, this being convenient for the landing-place. The anchorage southward of this line is reserved for vessels in *quarantine*.

Men-of-war and large vessels, especially if the roadstead is crowded, are recommended to lie farther to the north-eastward, where the bank of soundings is wider, and they will not be incommoded. A good position for a large ship would be in 28 fathoms, with Paso Alto Battery bearing North, and San Francisco tower about W. ½ N., 4 cables off shore. The holding ground seems better farther to the N.E., especially off the valley of San Miguel.

It is high water, on full and change, at $1^h\ 30^m$; springs rise 8 ft., neaps 6 feet. The flood sets N.E., and the ebb S.W.

Directions.—Lieut. Church remarks as follows :—" I have noticed that ships, coming from the north-eastward to Santa Cruz, run down at too great a distance from the land, and do not haul in till they get nearly abreast of the town. They thus get a cast or two of the lead with no bottom, and immediately they get into soundings, the anchor is let go in a hurry ; the bank being narrow, and the ship's head in-shore, there is little time for consideration. Instead of this method of proceeding, it would be advisable to haul in upon the bank of soundings immediately on passing Punta de Antequerra. I would get into the depth nearly that

I wished to anchor in, and then run down with the light wind parallel to the shore. Besides having time to anchor leisurely, there is the advantage of being enabled to let go the anchor under foot, wherever you may be. Should it fall calm while the ship is outside soundings, she may be taken away to leeward by the southerly set, which once caused us twenty-four hours' trouble to get back again. From experience, we adopted the system I have mentioned."

While running for the anchorage keep both leads going, and when nearing the town, care must be taken, in going in, not to bring any part of it to bear northward of West, lest calms should be occasioned by the high land under the peak, when you will be in danger of driving upon the shore. At night the mole lights form good guides.

In approaching Tenerife from the S.W., in summer, sailing vessels intending to call at Santa Cruz, are recommended to keep along the West shore, so as to profit by the more favourable wind there. In winter, they are advised to keep on the eastern side of the island.

The S.E. Coast of Tenerife is generally steep and clean, with deep water, but a few small bays and creeks afford anchorage for the coasters, for which the chart and the lead form sufficient guides. There are also several anchorages along the S.W. coast, where the shore is of rugged basalt, in some parts columnar.

Teño Point, the western extremity of Tenerife, is a curious projecting peninsula, whence the coast trends E. ½ N., 6 miles, to *Buenavista Point.* At 3½ miles S.E. ½ E. from the latter is the small town of *Garachico,* situated on a rounded bluff, and 330 yards off it is *El Roque,* a rocky islet, steep-to. Coasters anchor here, but the landing is bad. Inland will be seen a group of volcanic peaks, last in eruption in 1706, which completely destroyed the good harbour and town then existing here.

The N.W. Coast of Tenerife is more fertile and populous than the S.E. and southern districts of the island, the chief place of resort being the port of Orotava. At 2½ miles E.S.E. of Garachico is the town of *Icod de los Vinos,* standing above a small bight, in which there is anchorage in 4 to 10 fathoms, rock, only exposed to winds between West and North. Water may be obtained here. Between this and Port Orotava, 9 miles E. ½ S., are the towns of *San Juan de la Rambla* and *San Antonio,* off which vessels can anchor, if necessary, in 13 to 18 fathoms, sand and rock. In passing along this coast, the Peak forms a splendid object in fine weather.

Port Orotava, open to foreign shipping, is situated about the middle of the northern side of Tenerife, and in approaching from seaward vessels must be careful not to confound this town with that of Garachico, both being similarly situated on the coast. Rocks here extend nearly one-third of a mile off shore, on which the sea breaks furiously, but at the eastern part of the town is a small artificial harbour, where boats can always easily land.

Off Orotava the bank of soundings is from three-quarters to 1½ *mile* wide, wider to the northward, the depth decreasing suddenly from 100 to 55 fathoms, and then more gradually. The bottom consists of gravel and shells, and the usual anchorage is in 50 fathoms, nearly 1 mile off shore, with the Peak and the town bearing about S.W. ½ W.; and it is advisable for a sailing vessel to keep a pilot on board whilst lying here. It is a good anchorage in the summer season, or from the beginning of May to the end of October, when it is commonly calm in the road, but there is almost always a long northerly swell, which causes ships to roll very much. In winter ships are often obliged to slip their cables and put to sea, lest they should be surprised by a N.W. wind, which throws in a heavy sea; luckily these winds rarely happen, and in general give warning, so that a vessel has time to get away.

Orotava, the town next in importance to Santa Cruz, with which it is connected by a good road, is about 2 miles inland to the S.S.E. of the port, at an elevation of 1,042 ft. above the sea, in the most fertile part of the island.* It stands upon a gentle slope at the foot of the mountain, and is surrounded by fields of corn, gardens, and vineyards. The culture of the soil is here promoted to a very great degree, some patches so elevated and so secluded as to appear inaccessible to the husbandman. But the plain is very forbidding: and the beach is composed of naked, pointed, and cinereous, or scorched rocks. This is the principal wine district, and it is now much frequented by visitors in winter, for whom good hotel accommodation has been provided.

As a rule, sailing vessels will have no difficulty in making Port Orotava, either from the eastward or the westward, by keeping a considerable distance off shore. When the white town of Orotava comes in sight, below it will be seen two green hills of regular form, and by heading for a point between these hills the port will soon come into sight, and by day pilots will be ready to conduct the vessel to the anchorage. The land being so high, vessels must run in boldly, as before explained at Funchal, on pages 767—768.

Hidalgo Point, the northern extreme of Tenerife, 9 miles W. by N. from Anaga Rocks, is low and sandy, and surrounded by rocks, but there is good holding ground near the village of *La Hoya* on its southern side. Between this and Anaga Point, the bank of soundings widens to 2 and 3½ miles, dropping suddenly on its edge from 50 to 100 fathoms.

GOMERA, 14½ miles westward of Tenerife, with a deep and clear channel between, is of an oval form, 14 miles in extent E.S.E. and W.N.W., with an area of 172 square miles. Its shores are rugged and mountainous, but the central part of the island is a high irregular plateau, the highest point of which is *Alta Garaone*, elevated 4,400 feet. At the census in 1887, the population numbered 14,140, chiefly engaged in agriculture, for the numerous mountain streams render the land very fertile. Grain is produced in considerable quantities, together with the usual fruit and vegetables of these islands.

The coast of Gomera consists almost entirely of high cliffs, with a few off-lying rocks, and some small sandy beaches, on one of which, at the eastern end of the island, is the town of San Sebastian, the only port open to foreign shipping. The bank of soundings varies in width from 1½ mile, on its southern side, to 4½ miles on its northern side, the depth increasing rapidly from 50 to 100 fathoms.

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* The famous *Dragon Tree* of Orotava, whose age was variously estimated by botanists at from 5,000 to 10,000 years, was completely destroyed by a storm in 1867, and not a vestige remains. Its site, in one of the gardens, is now occupied by a seedling of the old tree.

Winds.—In summer, the Trade Wind is felt on the eastern side of Gomera, but on the West the usual calms or S.W. wind will be found. In winter, N.W. and S.W. winds are prevalent, and in spring they are fresh from the N.E. Violent squalls sometimes descend from the ravines of the N.E. coast.

Tides.—It is high water at Gomera and Palma, on full and change, at $1^h 45^m$; the flood sets to the North, and the ebb to the South, attaining considerable velocity at springs.

Port Gomera is the small sandy bay on the South side of the East end of Gomera, on the northern angle of which is the town of *San Sebastian*, where boats can land in any weather. Some refreshments can be obtained here, and the town has plenty of good water, which is drawn from wells in every part of it; and in the winter, a large rivulet from the mountains empties itself into the port. On the South side of the mouth of this rivulet stands an old round tower; and on the top of its perpendicular cliff, on the North side of the cove, is a chapel and a small battery.

Vessels anchor as convenient, in depths from 15 to 7 fathoms, sand and coral, and when close in are sheltered from all winds, except the S.E. As the land-wind frequently blows hard, it is necessary for a ship to moor with a large scope of cable, otherwise she will be in danger of being blown out of the bay. On the North side of the bay is a cove, where ships of any burthen may haul close to the shore, which is a high perpendicular cliff, and there heave down, clean, or repair. When boats cannot land on the beach, on account of the surf, they put ashore in this cove, from whence there is a pathway along the cliff to the town.

In taking this anchorage, everything should be prepared for letting go, in case the wind should haul ahead. Captain Glas states that *San Cristoval Point*, the easternmost point of Gomera, "when one is to the northward of it, at about 3 miles distant, bears a great resemblance to Rame Head, near Plymouth Sound. In going into the bay, it is necessary to stand close in with this point, for the land wind is commonly too scanty for a ship to fetch the proper anchoring place; from that reason it is better to come in with the sea breeze, which generally begins to blow here about noon. The best place for a ship to lie in is where a full view may be had along through the main street of the town, and at about a cable's length from the beach. It is necessary to moor as soon as possible, because of eddy winds that sometimes blow in the bay."

Bermeja Rock, with less than 6 ft. water over it, lies nearly 2 cables off shore, at less than 1 mile northward of San Cristoval Point.

There are several other anchorages around Gomera, those on the West being more suitable during summer, and those on the East during winter. Those on the N.E. are westward of *Mahona Point*, and off *Valle Hermosa*, S.E. of *Organo Point*. Northward of *Calera Point*, the western extremity, is the *Playa de los Ingles*, off which there is anchorage. Along the S.W. coast are several bights, and a tunny fishery has been established at *Calera*.

1¼ mile N.W. of *Becerro Point*, the southern extremity of the island. Eastward of the latter is *Erece Bay*, and inland is the large village of *Alajero*. Vessels also anchor off the *Playa de Santiago*, 2¼ miles farther eastward.

PALMA, the north-westernmost of the Canary group,* lies N.W. ¼ N. from Gomera, from which it is separated by a deep clear channel 30 miles wide. It is heart-shaped, 25 miles in length N. by E. and S. by W., and 13 miles in width at its North end, tapering off to the South, thus having an area of 318 square miles. It is very mountainous, being higher than the general level of Tenerife, the Peak excepted. Near the centre of its northern part rise three lofty volcanic peaks, *Pico de la Cruz*, the central one, attaining an elevation of 7,730 ft., whence the ridge trends off to the South end of the island, with several peaks not much inferior in elevation. From the western peak, the ridge trends round S.S.W. to the West coast, and in the angle thus formed a deep gorge runs up from the sea to the remarkable crater called the *Caldera*, in which is a mountain 2,320 ft. high. For a great part of the year, the mountains are capped with snow, but their sides are well wooded.

Palma is well supplied with water, and the land is therefore rich and productive. At the census in 1887, the population numbered 39,605, but the only town of any importance is Santa Cruz, and this is the only port open to foreign shipping. The fruit raised on this island is of superior quality, and there is a small factory for tinning it for export. Silk is also grown on a small scale. Altogether, some consider Palma to be the most attractive island of the group, in point of vegetation, scenery, and climate.

The coast is generally safe to approach, there being but few off-lying rocks, but the bank of soundings is very narrow, being nowhere more than 1¼ mile in width. In winter, the best anchorages are on the East coast, and in summer on the West. H.M.S. *Challenger*, in July, 1873, when dredging under the lee of Palma, found the surface water setting northward, at about 1 mile an hour.

Winds.—Palma is said to experience more westerly winds and fog than the other islands, but the prevailing wind in summer is fresh from the N.E., though calms and S.W. winds then occur on the West coast, as at the other islands. In winter, they range between S.W. and N.W., through West. Extremely violent and dangerous squalls sometimes come down the gorges, especially on the N.E. coast.

The N.W. and northern coasts are bold and cliffy, the cliffs attaining an elevation of 1,100 ft. at *Gorda Point*, the western extremity. The S.W. and East coasts are formed by alternate bluffs and beaches.

Cumplida Point Lighthouse, on the N.E. extremity of Palma, is a dark gray tower 112 ft. high, showing a *revolving bright* light, attaining its greatest brilliancy once every minute, elevated 207 ft., and visible 21 miles, over an arc of 239°, limited on the West by Gaviota Point, and on the S.E. by Barlovento Point.

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* St. Brandon or San Borondon Island was reported by old navigators to lie to the North or N.E. of Palma, and is said to have been landed on by a Scotch monk, from whom its name is derived, in A. D. 565; its last recorded appearance was in 1759. The most rational explanation of this mysterious island is that of *mirage*, and its reported appearance is similar to that of Palma, higher at the ends than in the centre.

Inland, to the S.W. of Cumplida Point, are five high hills, conspicuous when bearing S.S.W.

Santa Cruz de Palma, the port and chief town of Palma, is situated 9¼ miles southward of Cumplida Point. It stands on a sandy beach, and is of considerable size, containing about 6,000 inhabitants. In approaching from sea the first objects seen are a church on one of the heights and some windmills. It has several forts, on either side, and near the mole is a castle or battery. In the middle of the town, near the great church, is a fountain, filled by a rivulet, which plentifully supplies the inhabitants with good water. Fresh provisions, also, are abundant, and there is telegraphic communication (page 779).

A mole extends about 100 yards in a southerly direction, into a depth of 5 fathoms, and it has been proposed to extend this for about 300 yards farther, into a depth of 10 fathoms, thus enclosing a sheltered area with depths of 5 to 6 fathoms. A small *fixed red light*, elevated 24 ft., and visible about 4 miles, is shown on the mole.

Captain Glas states that, in approaching the centre of Palma from the eastward, the island will appear shaped exactly like a saddle. Steer so as to fall in a little to windward of the lowest place, or middle of the saddle, till within a mile of the land; then, running along shore to the southward, the town will be perceived close by the shore, and the shipping lying in the road; but, as the land behind the town is high and steep, one cannot discern the shipping till within a mile of them. The road is within a musket-shot of the shore, where vessels commonly ride in 15 or 20 fathoms of water, and are exposed to easterly winds; yet, with good anchors and cables, they may remain with great safety in all winds, for the ground is clean and good, and the great elevation of the island, with the perpendicular height of the land facing the road, repels the wind that blows upon it, though never so strong.

When there is a great N.E. swell at sea, it comes rolling into the bay, but the want of wind and the deepness of the water deprive it of strength and power; so that ships, in such a case, ride here with a slack cable. These circumstances render this road more secure than any of those of Canaria or Tenerife; but in winter the rolling swell breaks high upon the beach, and prevented boats from going off, or landing, sometimes for the space of three or four days together, before the mole was built.

It is advisable to have the aid of a pilot in anchoring, as there are some rocky patches to be avoided, unfit for anchorage.

From hence to *Fuencaliente Point*, the southern extremity of Palma, and thence to the town of Taxacorta, the bank of soundings is extremely narrow, 100 fathoms being found at less than 2 cables from shore in some parts.

Taxacorta, or *Tassacorta*, the only other place of any note in Palma, is situated on the western coast, opposite Santa Cruz. It contains about 1,500 inhabitants, and is built on a rocky plateau at the entrance of the great ravine leading up to the Caldera. The bank of soundings here widens to 1¼ mile, 20 fathoms being found about half a mile off, but the coast should not be closely approached, as some rocks lie off shore, North and South of the town.

The only anchorage on the West coast is off Taxacorta; this is exposed to westerly winds, and is only frequented by coasters, the port not being open to foreign vessels. It is better to approach this anchorage from the northward, owing to the prevailing wind and current to the southward, and there will be no difficulty in making out the position.

HIERRO, or Ferro, the westernmost, is also the smallest of the seven islands, and lies 33 miles W. by S. from Gomera, and 36 miles S.W. by S. ½ S. from Palma, with deep and clear channels between. It is of peculiar form, somewhat triangular, 15½ miles in its greatest extent, East and West, and from 3½ to 5½ miles in width, with an area of 122 square miles. It rises steeply from the sea to a high uneven plateau, attaining an elevation of 4,580 ft. on its S.W. side, and 4,990 ft. near the centre of its N.W. side, where the sides of the mountains rise almost perpendicularly, and between Salmone and Dehesa Points are known as the *Risco de Tavetai.*

The climate being somewhat moist, owing to fogs and dew, the island is well wooded, producing many varieties of trees and shrubs, with better grass, herbage, and flowers, than any of the other islands, so that bees and honey abound. The wine is poor, and there are only three fountains or streams of water on the island, and one of these is warm and sulphurous. At the census in 1887, the population numbered 5,897, *Valverde*, the chief town, being situated among the mountainous peaks at the N.E. end, 1½ mile from the sea.

The shores of Hierro, as a rule, are almost inaccessible, being steep and craggy, rendering the ascent to the plateau very difficult, and there are a few off-lying rocks, the most distant being those extending half a mile W.N.W. from *Salmone Point*. The bank of soundings is extremely narrow, in no part being wider than two-thirds of a mile. The deep bight on the N.W. side is known as *El Golfo*. It only affords anchorage in two places, at Port Hierro on the East, and Port Naos on the S.S.W., but they are both bad and exposed to S.E. winds.

Port Hierro or *San Juan*, 4 miles South of the North point, is only a slight inlet, with a sandy beach between two rocky points, off the northernmost of which is a detached islet. In approaching from the northward, beware of a sunken rock, with less than 6 ft. water over it, lying one-third of a mile E. ½ S. from the islet, and 2 cables off shore. The bank of soundings here is not half a mile wide, the depth suddenly decreasing from 100 to 20 fathoms; the anchorage is dangerous, and vessels should weigh or slip immediately the wind veers to S.E. or South. There is a road hence to Valverde, where supplies of provisions may be obtained.

Port Naos is a small bight in the cliffs, two-thirds of a mile N.W. of *Restinga Point*, the southern extremity of the island. It has depths of 9 to 11 fathoms, but is only used by coasters or fishermen, there being no inhabitants here.

DIRECTIONS FOR SAILING AMONG THE CANARY ISLANDS, BY CAPTAIN GLAS.

If a sailing ship, lying at the island of Palma, wants to proceed to Lanzarote, and will not wait for a fair wind (which, indeed, seldom blows there, especially in the summer season), let her stand over to the N.W. side of Tenerife, and beat up along shore until she weathers Anaga Point; thence, with the wind that generally prevails in these parts, she will be able to weather Canaria, and fetch Point Jandia, Fuerteventura, or perhaps Morro Jable, the southern point, whence it is easy to beat up to Pozonegro, along the East side of the island, because there the sea is always smooth. It is not quite so easy to beat up from Pozonegro to the Isle of Lobos; yet it may be done without difficulty when the weather is moderate. If the wind should happen to blow hard, she may stop in the Bay of Las Playas, until it proves more favourable. From the Isle of Lobos, she will find no difficulty in beating up to Puerto de Naos, in Lanzarote.

It is common for ships that come loaded from Europe to Santa Cruz, Tenerife, to have part of their cargoes to unload at Port Orotava; these ships, when the Trade Wind blows hard, will sometimes find it impracticable to weather Anaga Point. When this is the case, bear away to the leeward point of the island (Rasca Point), and keep near the shore, where, if you do not meet with a southerly wind, you will be carried by the current, in the space of twenty-four hours, from the S.W. point of the island to Point Teño, whence you may easily beat up to Port Orotava; for when the wind blows excessively strong at Anaga Point, it is moderate weather all the way from Point Teño until within 2 or 3 leagues of Anaga Point. But I would not advise a ship to bear away as above directed, unless when the Trade Wind blows so fresh that she cannot weather Anaga Point; because in moderate weather there is little or no wind stirring on the coast between Teño and Port Orotava.

The COAST of AFRICA, eastward of the Canary Islands, is fully described previously, on pages 628—632, &c.

6.—THE CAPE VERDE ISLANDS.

The CAPE VERDE ISLANDS, belonging to Portugal, derive their name from the nearest point of the African coast, Cape Verde, which lies about 308 miles S.E. by E. from the island named Boavista. They were discovered in the year 1460, by the Portuguese navigator Diogo Gomez and the Genoese pilot Antonio de Nolle, St. Iago being the island first sighted and then so named.* They consist of ten large islands, and four smaller ones, lying between the parallels of 14° 46′ and 17° 12½′ N., and the meridians of 22° 40′ and 25° 22′ W. The northern islands, from St. Antonio to Boavista, are known as the *Ilhas de Barlovento* or *Windward Islands*, and those to the southward, from Maio to Brava, as the *Ilhas de Sotavento* or *Leeward Islands*. St. Iago is the seat of government, though St. Vincent is of most commercial importance. Sal, the N.E. island, lies 700 miles S.W. ½ S. from Hierro, the nearest of the Canary Islands.

The islands are volcanic in their origin, and mountainous, with large barren areas of lava and sand, owing to the great scarcity of water. Where cultivation is possible, all Tropical products grow readily in abundance, such as sugar, coffee, maize, cotton, tobacco, manioc, sweet potatos, &c.; the principal trees are the tamarind and palms. Goats and poultry are raised in considerable numbers, with cattle, sheep, horses, &c., and fish and turtle are found around the shores. The inhabitants, numbering about 100,000, are chiefly of Portuguese and negro origin. The islands appear to have been uninhabited at the time of their discovery.

These islands are of no great commercial importance, but of recent years coaling stations have been established at St. Vincent and St. Iago, frequented by large numbers of vessels. These are connected by telegraph cables with Europe, South America, and the West coast of Africa. The exports are chiefly coffee of good quality, grown on St. Antonio, St. Iago, and Fogo; sugar and rum; salt, made in large quantities on Sal, Boavista, and Maio; orchilla; and red or precious coral, at St. Iago and St. Vincent.†

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* The following is a translation of the narrative of Diogo Gomez, as given in Mr. Major's "Life of Prince Henry," pages 297—298:—"I and Antonio de Noli then left that port of Zaza, and sailed two days and one night towards Portugal, and we saw some islands in the sea, and, as my caravel was a lighter sailer than the other, I came first to one of those islands, and saw white sand, and it seemed to me a good harbour, and I cast anchor there, and so also did Antonio. I told them that I wished to be the first to land, and so I did. We saw no sign of any man there, and we called the island Santiago. There was abundance of fish. On shore we found many strange birds, and streamlets of fresh water. There was also an abundance of figs, growing all over the bark from the foot of the tree to the top."

† Some particulars regarding the Cape Verde Islands are taken from a series of articles on the "Provincia de Cabo Verde," appearing in "As Colonias Portuguezas," January, February, and March, 1890.

In August, September, and October, the climate is very hot, wet, and unhealthy, and strong gales from the southward are experienced, also tornados and calms. The rest of the year is known as the dry season, and, though hot, is healthy, probably owing to the strength of the N.E. Trade Wind. Destructive droughts sometimes occur, especially in the Windward group, causing great distress. Observations show that the mean temperature ranges from 64° F. in March to 84° in July.

Winds.—Among the Cape Verde Islands the N.E. Trade Wind blows from January to March, varying between N.E., North, and N.N.W., and the Harmattan also occurs. From April to June it blows North, N.E., and East, weakening in force as it draws to the eastward. From July to October the Trade Wind is varied by winds between S.E. and S.W., with squalls, tornados, calms, rain, and fog. In November and December the Trade Wind blows between N.N.E. and East, and the Harmattan is also felt. Land and sea breezes blow near the coasts, and calms extend some distance to leeward of each island, as at the Canaries. In December, January, and February, the fine dust blown from the African desert frequently envelops the islands in a dense haze, when the greatest caution is necessary in making the land. Some remarks on this have been given previously, on pages 499—500.

Currents.—The North African Current (see pages 312—324) sets down upon the Cape Verde Islands, in a south-westerly direction, at the rate of about 12 miles a day, influenced by the prevailing wind. This set is more uncertain and irregular among the eastern islands, and has been the cause of several wrecks. Rollers are frequent in July, August, and September, most violent generally at full and change of the moon.

The channels between the islands, and between them and the coast, are deep and clear, with the exception of the dangerous Leton Rock, between Boavista and Maio, but all precautions must be taken in approaching, owing to the frequent fogs and the uncertainty of the currents. To the eastward and N.E. the water is frequently much discoloured. Sailing vessels will find it advisable to approach from the northward; from the southward, they will experience calms and squalls, and the Trade Wind blows strongly between the islands, and causes a rough sea. If not bound to any port in the islands, it is advisable to pass westward of the group.

Instances have occurred of vessels coming from the Canaries being set far to the eastward or westward of their supposed position, even though the passage is so short.*

ILHA de SAL, the N.E. island of the group, is 16 miles long, North and South, 7 miles wide in its northern part, which is rocky and mountainous, but much narrower towards the South, where it becomes very low and sandy, and terminates in *Wreck Point*, a dangerous low sandy projection, with rocks extending half a mile off. It has little or no vegetation, and in the interior are some salt-ponds, whence Sal derives its name.

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* Mr. Finlaison states that, "In leaving Tenerife for the Cape Verde Islands, you will certainly have the wind from E. by S. to N.E. as you approach the islands." He also adds, that in the passage a current was generally found setting *from S.S.W.* at the rate of half a mile an hour, which is contrary to the current on the African coast. (See pages 312—324).

Herein the water crystallizes into a beautiful salt, the chief production of the isle, as the land is so barren as to bear no trees or verdure, excepting a few inconsiderable shrubs. The salt is brought down to the coast by tramway. In 1879, the inhabitants numbered 1,082.

The shores of the northern part of Sal are abrupt and cliffy, but bordered with rocks and reefs, and in approaching from the North, it will be found in general that the currents are very irregular. In clear weather, you may see the high land at 40 miles off; sometimes at a greater distance. The land makes in three hillocks, of which the northernmost is the highest; this is the *Peak of Martinez*, in the N.E., the summit of which is 1,340 ft. above the level of the sea.

The best roadsteads of Sal are on the western side of the island; but there are three small bays on the eastern side, and one on the South. The middle bay on the eastern side, where a ship may lie, is apparently sheltered from the N.E. by a sandy reef stretching out to the eastward, and here salt may be obtained. The other bays on this side are open to the N.E. Trade Wind, which makes a very heavy sea on the beach.

Great caution is required on approaching the South end of the island in the night, it being so low as hardly to be seen 10 miles off in the day. Keep your lead going, and approach no nearer than in 30 fathoms, unless bound into South Bay.*

Palmira Bay is a small bight 4½ miles southward of *Manuel Point*, the N.W. point of Sal, where a few trading vessels moor under shelter of a reef extending off its northern point. If necessary, vessels could anchor in 10 to 17 fathoms at 1 mile off, but exposed to all winds, and there is usually a heavy sea. At 3 miles farther on is *Lion's Head*, 620 ft. high, close off which lies *Bird Islet.*

Mordeira Bay, immediately to the S.E. of Lion's Head, is one of the best anchorages in the Cape Verde Islands. It is semi-circular in form, 3½ miles wide between its outer points, Lion's Head and Turtle Point, with depths of 9 to 12 fathoms between, sheltered from winds between North and N.E. It is unsafe, however, during the rainy season, when southerly winds blow in, accompanied by rollers. A good berth is in 9 to 12 fathoms, with Bird Islet just shut in with the foot of Lion's Head, about 1 mile off shore, and Turtle Point bearing South. The ground should be examined before dropping the anchor, as there are some spots of foul ground. Delicious fish and turtle abound here, but there is no fresh water, even by sinking casks in the sand. It is high water, on full and change, at $7^h\ 45^m$; springs rise about 5 feet.

Turtle Point, the South point of Mordeira Bay, is low, with shoal ground of coral extending more than a mile westward of it, with depths of 3½ to 5 fathoms, on which the French frigate *Résolue* touched in 1881. Consequently, vessels should give the point a wide berth in passing. From Turtle Point to *Sino* or *South Point*, the distance is 4½ miles. The ground between is smooth, and has 7 fathoms over it, at half a mile from shore, which is sandy; but be careful, if you anchor, that the ground is clear. In rounding South Point, beware of the dangerous sand-spit extending over 1 mile S.S.E. from the lighthouse; this is steep-to, with depths of 8 to 14 fathoms close to it.

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* The noise of the surf will often give ample warning in approaching land, either during a fog or by night, and ought to be attended to, if heard; but no one ought to run rashly, making certain of hearing it.—*A. Livingston.*

The Lighthouse on South Point is a square red iron structure, 19 ft. high, about 1 mile S.W. of the village, showing a *fixed bright* light, elevated 31 ft., and visible 8 miles seaward, between S.E. ¾ E. and N. ¼ W.

South Bay, between South and Wreck Points, affords anchorage in fine weather, off the village of *Santa Maria*, sheltered from the Trade Wind. In entering, beware of the sand-spit off South Point, and the rocks around Wreck Point, and anchor in 7 to 9 fathoms, sand, with the lighthouse bearing about N.W. ¼ W. Vessels can also anchor in 7 fathoms, half a mile West of South Point; this anchorage is known as *Port Salina*, from the adjacent salt-pans.

East Point, 5 miles N.E. by N. ¼ N. from Wreck Point, has a small conical hill near the edge of the cliff. *Firestone Hill*, 6 miles farther on, is a promontory, at the back of which is *Salt-pond Hill*, a natural curiosity, as upon this is a circular salt-pond, 150 ft. above the level of the sea. The surface of the pond is 45 ft. below the top of the hill.

In the channel between Sal and Boavista, the south-westerly current generally sets strongly upon the latter island and its off-lying reefs. Consequently, vessels are advised to keep well over toward Sal, and to avoid this channel altogether when the position is at all doubtful.

BOAVISTA, or Bonavista, was so called from the beautiful appearance it made to its discoverers in the year 1460. It is roughly of a circular form, about 9 miles in diameter, its shores consisting of long sandy beaches, separated by projecting rocky points, off which reefs extend. A range of mountains runs North and South through its centre, separated by deep valleys from other isolated hills; *Mount Juan Fernandez*, 1,260 ft. high, the loftiest and northernmost summit of this range, has three peaks. Formerly fertile, it is now almost barren, salt being the chief article of trade, quantities of which are made at salt-pans near the East point of the island. In 1887, the population numbered 2,643. English Road is the chief place of resort. Fresh water is very scarce.

Reference has previously been made to the uncertainty of the current setting upon Boavista. Heavy rollers, also, are sometimes experienced, rendering anchorage unsafe. In the rainy season, which is during the months of July, August, and September, Boavista is subject to light airs and changeable winds, with heavy swells in the bay and roadsteads.

Sol Point, the North extreme of Boavista, lies 21¼ miles S. by W. ¾ W. from South Point of Sal, and has foul rocky ground extending three-quarters of a mile North of it. *North Bluff*, 1¾ mile to S.S.W., is steep and cliffy, and midway between is a reef, half a mile off shore, which generally breaks. At 2 miles S.W. by S. of North Bluff is *Sal Rei* or *Small Island*, 1 mile long, N.W. and S.E., and connected with the shore N.E. of it by a reef, half a mile long; a bank also extends half a mile from its N.W. point.

The Lighthouse on the centre of Small Island is a red iron building, 20 ft. high, showing a *fixed bright* light, elevated 91 ft., and visible 8 miles.

English Road, or *Porto de Sal Rei*, is the sandy bight between Small Island and Coral Point, 4½ miles to S.W. ½ S. Depths of 8 to 11 fathoms are found on this line, but a small dangerous bank named *Ten-feet Reef*, with only 10 ft. water over it, lies about three-quarters of a mile S.W. of the lighthouse. This bay affords safe anchorage in summer, when N.E. winds are prevalent. The old village of *Sal Rei* lies in the northern angle of the bay, and the new town of *Rabil* lies 2½ miles to S.S.W., with numerous salt-pans between. Boats can land at all times at Sal Rei mole. The church tower at Rabil forms a good mark for the anchorage; a reef lies close off the village, with 9 fathoms close to it, and a bank extends hence to *Inner Reef*, lying half a mile E.S.E. of Small Island.

Coasting vessels generally haul close round Small Island, in 6 and 7 fathoms, and pass North of Ten-feet Reef, in order to avoid the necessity of making a tack to get to the anchorage. The best mark for the latter, in 6 to 5 fathoms, is the village of Sal Rei open of the N.E. end of Small Island, and the summit of that island about North. Ten-feet Reef generally shows itself by the breakers; but when this is not the case, a stranger will do well to stand outside, rounding it at about 1½ or 2 miles from Small Island, approaching it no nearer than in 6 fathoms, and, after once opening the village of Sal Rei, taking care not to shut it again. Rabil church bearing E. by S. leads well clear of the reef. It is high water, on full and change, at $7^h\ 30^m$; springs rise 5 feet.

Mr. Keilor remarks:—"We experienced in a calm a very large sea, breaking in every part of the bay, and were at the same time riding with a very short scope of cable, by reason of a strong current setting out of the bay, against the sea; this current ran so high as to frequently break on the deck."

Areia or *Coral Point* is low and rocky, and at 2 miles W. by S. from it is *Coral Reef*, a small islet surrounded by rocks, and apparently connected with the shore to S.E. ½ E., the coast here being fronted by breakers; at times the current sets very rapidly on to this reef. *Varandinha Point*, 3 miles to S.W. by S., is a low sandy projection, within which is *Platform Hill;* N.E. of the latter is an elevation called *Man Mountain.* At 11 miles S.E. ½ S. from Varandinha Point is Curral Velho Point, the coast between being low and sandy, with foul ground extending off the points.

Curral Velho, *Urrateo*, or *South Point*, is a cliffy projection from the low sandy coast, with foul ground around it.* At three-quarters of a mile E.S.E. of it is *Curralinho Islet*, also low and foul. To the westward of the point there is anchorage in what is called *Portuguese Road*, with Platform Hill bearing about N.N.W., and nearer inshore, in from 13 and 14 to 8 and 6 fathoms, whence the landing place will bear N.E. by N. Vessels here lie sheltered from N.E. winds.

Between South Point and Brazen Hill Bluff, 8 miles to E. by N. ½ N., the coast consists of a low sandy beach, above which rises *South Mountain.* *Brazen Hill* or *Orvatao Bluff* is a remarkable sharp perpendicular point, on which stands the conical *East Hill.* At 4½ miles N.E. of it is *East*

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* *Sabatina Shoal.*—A shoal of 8 fathoms water was reported to lie nearly 7 miles S.W. by W. ½ W. from South Point, but its existence is extremely doubtful.

Sand Head or *Reef Point*, the low dangerous eastern extremity of Boavista; rocks extend 1 mile off it, and also off *Point Ferreira* to the S.W. Inland are some extensive salt-pans.

Reefs, &c.—Between Reef Point and Hartwell Point, 6 miles to N. ¾ W., the N.E. coast of Boavista forms a bay called *Porto do Norte* or *do Canto*, fronted by dangerous detached reefs, on which lie three islets. The long list of wrecks on Hartwell Reef, and the fact of so many vessels being to the westward of their reckonings, and that in the short run from Madeira or the Canaries, will give great weight to the fact of the westward tendency of the currents, which, as stated before, tend directly towards this formidable danger, and therefore all vigilance and care are imperatively necessary for the safety of ships passing this place.[*]

Hartwell Reef, on which the East Indiaman of this name was lost in 1787, is the northernmost of these dangers, and reaches nearly 4 miles E.S.E. off the North point of the bay; on its southern side, 1¼ mile off shore, is *Braithwaite Islet*. This reef is very dangerous, being steep-to, 100 fathoms being found at half a mile eastward of it.

Mr. R. Keilor, H.M.S. *Bulldog*, 1788, remarked that between these reefs and islets there is sufficient depth of water for ships, in case of necessity, and proper depths for anchorage, under the lee of the reefs; but many rocks are here scattered, with only 12 or 13 ft. water over them, and 4 fathoms close along them, on which, with a wind, the sea breaks very high. Of the channels between these reefs, the best lies between Braithwaite or the Middle Kay, which is always visible, and *Dutch* or the *South Kay*, 2¼ miles to S. ¼ E. This channel is three-quarters of a mile broad, and has regular soundings, from 15 to 5 fathoms; it was used by H.M. sloop *Bulldog*, which often sailed in and out of it, and several times anchored under Braithwaite Kay, with that islet bearing N.E. by E.

North Kay is connected with the shore by a reef, having only 5 ft. of water over it. In line with the conical summit of *Mount Ochel* or *Oxello*, the N.E. mountain in Boavista, it bears about W. by S. The passage between this and the western end of Hartwell Reef is half a mile wide, with 7 and 8 fathoms least water.

The passage between Dutch Kay and the reef off Reef Point is narrow, with 7 fathoms water in it.

In sailing out to the south-westward, with the wind easterly, stand well to the southward, taking advantage of the current here setting easterly, and take care not to borrow too near the back of the reefs.

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[*] BONETTA ROCK (?).—In April, 1835, the ship *Madeline* was reported to have struck and been wrecked on a reef, at about 8 leagues E.N.E. from Boavista, or in lat. 16° 17′ 20″ N., long. 22° 23′ 50″ W. Other reefs have also been reported far to the eastward and N.E. of Boavista. Captain Vidal, by his researches in the *Ætna*, satisfactorily proved that no such dangers as the Madeline or Bonetta Reefs have any existence. These imaginary dangers were also sought for in vain by the American Exploring squadron, and the result seems to be, that the *Madeline* was impelled to the S.W. by the current, and wrecked on *Hartwell Reef* off Boavista. Lieutenant Lee, U.S.N., on the cruise of the *Delphin*, found a depth of 1,580 fathoms on one spot, in about lat. 17° N., long. 21° 40′ W., near the reported site of *Emily Rock*, and great depths close up to the islands.

Passing vessels, however, are recommended to give this dangerous region a very wide berth. Brazen Hill Bluff open East of Reef Point, S.W. by W., leads clear eastward of the reefs; and Sol Point open North of Broyal Point, W. by N. ½ N., leads North of them. In sailing from the South end of Sal, to pass eastward of Boavista, vessels must steer at least two or three points eastward of the compass bearing of the reefs, to allow for the current setting down upon them.

Broyal or *Derrubada Point*, 4 miles N.W. by W. from Hartwell Point, is a wide rocky projection, with foul ground around it, and to the South of it is the conical *Mount Broyal.* Between this and Sol Point (page 806), 7 miles to W.N.W., the coast forms *Salina Bay*, with a sandy beach, but rocks extend 2 miles off it.

Leton Rock, or *John Leton Rock*, is a dangerous coral reef, no part appearing above water, lying between Boavista and Maio Islands, in about lat. 15° 48′ N., long. 23° 9′ W., but its exact position has not yet been determined. Great caution is necessary in using this channel, especially at night or in thick weather, and in calm weather the position of the rock is not marked by breakers. It has been described as just even with the surface, and has soundings of 4 to 20 fathoms around it, over a space of about 1 mile in diameter. From it the South extreme of Boavista bears about E. ½ N., distant 21 miles, and Sol Point N.E., 28 miles.*

Leton Rock lies on the central part of an extensive bank of soundings, of an oval form, 15 miles in extent N.E. and S.W., within the depth of 100 fathoms, with bottom of sand, shells, and coral. It swarms with fish.

MAIO ISLAND, 43 miles S.W. ½ S. from Boavista, is of an irregular oval form, 12½ miles in extent N. by E. and S. by W., with a greatest breadth of 7½ miles, and attaining an elevation of 720 feet. When seen at a distance it appears like a group of islets, as the hills are separated by low sandy plains. Along its eastern side are *Mounts San Antonio, Pinos*, and *Maio*, and in the S.W. part are the three hills of *Balalha*, in line when bearing North or South. During the survey by Lieutenant W. Mudge, R.N., in 1819, the hills were found to be strongly magnetic, greatly deranging the magnetic needle of the theodolite.

The soil of Maio is generally dry and unproductive; wood is scarce, and there is but one spring of fresh water in the island. The coast is, however, plentifully stocked with fish, which supply, with a few vegetable productions, subsistence to the poor inhabitants, who numbered about 1,600 in 1879. Good cattle are bred in small numbers, but the manufacture of salt is the chief industry.

North Point is a low narrow projection, 2 miles in length, with rocks on either side. At 1½ mile East of its extremity is *Galhao* or *North Reef*, a dangerous group of rocks, 1 mile in extent N.E. and S.W., with foul ground between it and the shore. A depth of 45 fathoms, sandy bottom, was found on a bank 6 miles N.N.E. of Galhao Reef.

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* In 1890, an automatic *Whistle Signal Buoy* was moored near this rock, but it was found impossible to maintain it in position.

The East and West coasts of Maio are fronted by rocks, and the chart best shows their features. The South side is low and sandy.

English Road, the only place of any importance on Maio, is the sandy bay on its S.W. side, sheltered from winds between North and East, but entirely open to the S.W. Landing, as a rule, is very bad. Near the village are extensive salt-pans. *Town Point,* the South point of the bay, has foul ground extending 4 cables off it. The shore to the eastward and abreast of the village is steep, bluff, and rocky; but, to the westward, a low white sandy beach extends to a rounding point, from which a spit of sand and coral stretches outward, at a short distance from the extremity of which there is no bottom at 45 fathoms. But few supplies could be obtained here, and no good water is to be had. It is high water, on full and change, at $6^h\ 30^m$; springs rise about 5 feet.

Caution is necessary in approaching the anchorage, as the bank is steep, and in the wet season vessels should be kept in readiness to get under way, in case of a westerly gale. Small vessels anchor in 6 and 7 fathoms, near the beach, but the usual anchorage is in from 10 to 30 fathoms; a good berth is in 12½ fathoms, half a mile off shore, with the village bearing East.

Light.—A *fixed red* light, elevated 62 ft., and visible 7 miles, is shown from a red turret on *Fort San José*, at the village.

Blisset Reef, 1½ mile S.E. of Town Point, reaches nearly half a mile off shore, with 7 fathoms close off it.

The channel between Maio and St. Iago is deep and clear, but sailing vessels should give the latter island a good berth, to avoid the calms and squalls, and the current sets on to it. Between July and October the winds here are variable. Ships running from Boavista to St. Iago, and being obliged to ply to windward during the night, must be cautious how they approach Maio, on account of the dangerous Galhao Reef, off the North point of it; having doubled that point, they may steer S.W. to make the land of St. Iago, and thence southward until they make the Road of Praya.

To the N.W. of St. Iago the westerly current sometimes runs at the rate of 1½ to 2 miles an hour.

ST. IAGO ISLAND, or **San Thiago,** the largest and principal island of the Cape Verde group, is 30½ miles in length N. by W. and S. by E., 13 miles in width in its central part, and narrowing to 4 miles in its northern part. It is very mountainous; *Mount St. Antonio,* its highest conical peak, attains an elevation of 7,400 ft.,* near the centre of the island. Several streams descend the ravines, affording water for a considerable area of cultivation, the ground yielding tropical fruit, vegetables, and other productions, such as coffee, sugar, &c., in abundance. Its southern part is swampy and unhealthy. The coast, as a rule, is rocky, with off-lying rocks in places. The population numbered 41,076 in 1879, Porto Praya being the seat of government.

Tarrafal Point, the N.W. extremity of St. Iago, is high and steep. On *Ponta Preta,* its southern extremity, is a lighthouse, and from hence the cliffy coast trends to the S.E., for 1 mile, and then bends round to the westward, thus forming a small bay in the angle, known as *Tarrafal Bay*. Here is a custom-house and the small village of *Mangue*, where the coast consists of sandy beaches, separated by rocky points. The depths decrease regularly towards the shore, and according to the Portuguese survey of 1890, there are no detached dangers. There is anchorage in 6 fathoms, about 1 cable off shore, North of the village, and the people say it is safe at all seasons. Farther out there is anchorage in 10 to 20 fathoms, fine sand and broken shells, protected from winds between N.E. and S.W., and only open to the N.W.[*] *Monte Graciosa*, the N.W. hill of St. Iago, bearing N.E. leads to the bay. Supplies of provisions and water may be obtained here.

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* In 1882, the captain of the French frigate *Talisman* stated that, from his observations, Mount St. Antonio is only about 4,420 ft. high.

Light.—On Ponta Preta a *fixed bright* light, elevated 111 ft., and visible 9 miles, is shown from a small red iron structure, 19 ft. high.

Ponta Bighuda, 2 miles E.N.E. of Ponta Preta, is very high and abrupt, and from hence the East coast of St. Iago trends to the S.S.E. All this coast is dangerous for sailing vessels, owing to the calms produced by the high lands, which reflect the N.E. winds, and by the currents and bad sea which are found on it. The only place worth mentioning is the little harbour of *Santiago*, which will scarcely hold four vessels of 100 tons. It lies about the middle of the coast, and may be known by some clumps of cocoa-nut trees and a small church to the South.

Light.—At *Porto do Lobo*, at the eastern extremity of St. Iago, a *fixed red* light, elevated 33 ft., and visible 7 miles, is shown from a small square white building.

Santiago Point, the S.E. extremity of St. Iago, 1 mile S.S.W. of Porto do Lobo, appears as a long low point from the N.W. or S.E., and is surrounded with breakers. West of it is a bay 2 miles wide, the western angle of which is *Portale* or *St. Francis Harbour*, into which runs a stream, and here are a few houses and some cocoa-nut palms. This bay so much resembles that of Porto Praya, that many vessels, deceived by the likeness, have run the hazard of being lost in this dangerous place. The land between Portale and Ponta das Bicudas, the eastern point of Porto Praya, 4 miles to S.W. ¾ S., is mostly perpendicular, appearing, in some places, like Berry Head, in Torbay; and though the town and fort of Port Praya, which stand on a small cliff, is a mark by which the true bay may be distinguished from the false one, yet the surest mark is, that Santiago Point, the East point of the false bay, is surrounded with breakers; whereas *Ponta das Bicudas*, the East point of Porto Praya, is high, steep, and free from shoals. At 1½ mile N.N.E of Bicudas Point is the conspicuous *Monte Faxo* or *Signal Post Hill*, but there is no signal station there at present.

Porto Praya is a fine bay, 1½ mile in width between Bicudas Point and Ponta Temerosa, to W. ¾ N., and within this line it extends 1 mile northward to the town at its head. Its eastern coast is high, cliffy, and indented, and the sandy bight N.W. of Bicudas Point is stated to be an excellent place for hauling the seine, as is also the head of the bay. The principal fish are mullet (gray and red), rock-fish, snappers, cavalla, and a variety of small fish. *Ponta Temerosa* is also high, but breakers extend a considerable distance off. From hence to abreast of Quail Island the West side of the bay is cliffy, and fronted with foul rocky ground. Abreast the North end of Quail Island is a small wooden pier, and between this and the town the coast is low and sandy, with some buildings on it, including the custom-house and landing-pier.

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[*] "Annalen der Hydrographie," Berlin, 1891, page 417.

Porto Praya has depths of 10 to 15 fathoms in the entrance, gradually decreasing towards the town, and affords safe anchorage during the dry season (December to June), but during the rainy season, strong southerly winds and heavy seas sometimes render it unsafe for sailing vessels; they should then anchor well out, in 17 fathoms. The bottom consists of sand and gravel, but is rocky over the western side of the entrance. In 1864, a bank of 6 fathoms was reported to lie in the entrance, and nearly South of the town. This may be a part of the 7-fathoms shoal, about 3 cables E.S.E. of the South point of Quail Island, or a continuation of it to the southward.

The town of *Praya* is built on land elevated about 100 ft., with a valley and palm groves on either side, and has about 6,000 inhabitants. It is the capital of the islands, the governor now residing here instead of at Ribeira Grande. On the sea-front is a fort, with a church West of it. Boats land at the new iron pier, which reaches into 2½ fathoms water, near the new custom-house, on the northern shore of the bay, the old stone mole at the town being in ruins. Supplies are plentiful, including fresh water, which is brought down to the custom-house pier in pipes, and can be brought off in tank vessels. Bullocks, of fair quality, pigs, fowls, &c., can be purchased at moderate prices, and abundance of vegetables and fruit in their season, such as sweet potatoes, cabbages, pumpkins, oranges, lemons, grapes, bananas, &c., which are exported to St. Vincent and the other islands. Coal is stored in considerable quantities on Quail Island, and can be put on board from lighters towed by steam-launches, at the rate of 200 tons a day. There is telegraphic communication with Europe, St. Vincent, Dakar, and other ports of West Africa. There is a good hospital here, and the port dues are light to vessels calling only for stores. Intermittent fevers are sometimes prevalent in the wet season; otherwise it is not unhealthy.

A *fixed red* light, visible about 2 miles, is shown on the end of the custom-house pier.

Quail, Frenchman, or *Santa Maria Island,* about one-third of a mile S.S.W. of the town, is one-quarter of a mile long, and about 53 ft. high. It is composed of black rock, nearly level on the top, but rugged at each end, with rocks extending half a cable off its N.E. and S.E sides. It lies 220 yards off the western shore of the bay, with which it is connected by a reef, only passable for small boats in fine weather. The coal stores are on the West side of the island, and at 1 cable N.E. of its North end are two hulks. On the South end of the island is a white tower 14 ft. high, surmounted by an iron tripod, on which a light was formerly shown. Vessels are recommended not to approach the island, on any point, nearer than half a mile, as the vicinity is rocky, and some rocks do not show.

Between the North end of Quail Island and the town is a conspicuous red building on the shore, and nearer the town is the custom-house, off which the new iron landing pier extends 400 ft., into a depth of 2½ fathoms. The Lazaretto is near the lighthouse on Temerosa Point, and here also is a *Signal Station.*

The Lighthouse on *Temerosa Point* is an octagonal white tower about 60 ft. high, showing a *fixed bright* light, elevated 85 ft., and visible 13 miles.

Directions.—In clear weather, the peak of Mount St. Antonio bearing N.N.W. leads direct to Porto Praya, but the high land is frequently obscured by haze. It is best to approach from the eastward, owing to the set of the current and the prevailing N.E. wind, especially in a sailing vessel. Before rounding Santiago Point, the S.E. extremity of St. Iago, it will be advisable to furl the top-gallant sails, and take a reef in the top-sails, as heavy squalls sometimes come off the land. In favourable weather, vessels can then keep along the coast, about 1½ mile distant, and passing close round Bicudas Point haul up for the anchorage.

When Bicudas Point bears N.W. by W., Temerosa Point will be distinctly in view, having *Red Hill* behind upon the same bearing; haul up then, and pass the point about three-quarters of a mile off. Quail Island (having a very black appearance) will then be seen to the N.W.; steer up for the North end of it till you fairly open the bay; then luff up to about N.N.W., and anchor midway between Quail Island and the eastern shore of the bay, in 7 fathoms, having Red Hill just open to the northward of the island. In sailing into the bay, keep well to the eastward, as the ground to the westward is foul.

If the wind appears to be light in the bay, sailing vessels should stand off and on outside, for fear of drifting on to the rocks.

If approaching Porto Praya from the westward, a sailing vessel will find it difficult to beat up to windward against the strong current which usually prevails here.

The best anchorage is, to bring the flagstaff on the fort N.W. by N. ½ N., distant about three-quarters of a mile; the South end of Quail Island W. by N.; and Bicudas Point E.S.E., in 7 and 8 fathoms. Many commanders prefer anchoring nearer the N.E. side of the bay than Quail Island, for the sake of getting more easily under sail, without running the risk of being carried by the currents upon the points of rocks to leeward, before the vessel has gained fresh way enough to steer clear of them; and it has been observed that vessels may anchor anywhere in the bay, from 9 to 11 fathoms, good bottom, but nearer to the eastern shore than to Quail Island, as the wind, except in the months of August, September, and October, generally blows from the N.E.

Within the bearing of E. by N. from the North end of Quail Island, the depth shoalens from 5 to 4, 3, and 2 fathoms.* It is high water, on full and change, at 6^h; springs rise about 5 feet.

To those bound from Praya to Boavista, Mr. Keilor recommends that they should endeavour to sail in the evening, as the current will be favourable. He adds:—Do not stand too far over toward the African shore, nor work between Maio and St. Iago, and you will find the ship get to the eastward very fast.

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* In 1892, a steamer lay stranded on the rocks about 1 cable N.E. of Quail Island flagstaff. To a stranger entering, she appeared to be lying at anchor, and would be liable to mislead.

Winds.—Captain FitzRoy, who visited this place in H.M.S. *Beagle*, made the following observations:—

" The wind being always from the North or East during this season of the year (December to June), a ship can moor as close to the weather shore as may be convenient; but during July, August, September, and October, no vessel should deem the bay secure, or anchor near the shore, because southerly gales sometimes blow with great strength, and the *rollers*, or heavy seas sent in by them, are dangerous to ships which have bad ground tackle, or are lying near the land. As I have myself experienced the force of these gales, in the vicinity of the Cape Verde Islands, and witnessed the sea raised by them, I can confidently warn those who are inclined to be incredulous about a gale of wind being found in 15° of North latitude, beyond the limits of the Hurricane regions.

" Strong gusts come over the land into the bay during the fine season, when the breeze is fresh; therefore, a ship entering with intent to anchor, ought to have a reef in her topsails, and be ready to clew up the topgallant sails at a moment's warning.

" From August to October is the rainy and sickly season. In September, a S.W. gale is usually experienced; but from five to ten hours before its commencement, a dark bank of clouds is seen in the southern horizon, which is a sure forerunner of the gale. Should a vessel be at anchor in the port at such a time, she ought to weigh and put to sea until the storm has ceased, and the swell subsided. In the month of September preceding our visit, an American merchant brig and a Portuguese slaver were at anchor in Port Praya. A bank of clouds was seen during the day in the S.W., and the American went to sea; but the slaver remained at anchor. A storm arose at night, drove the slave-vessel ashore, and dashed her to pieces in less than half an hour, yet did the American no danger whatever, and the next day she anchored again in the port.

" Except during the rainy season, the wind is always north-easterly, and then the sky is clear and the sun very powerful; but a dry haze hangs over the island in a peculiar manner, and a quantity of fine dust, quite an impalpable powder, frequently settles on every exposed surface, even on the sails and rigging of a vessel, when passing near the islands."

In settled weather, there are often regular land and sea breezes in the bay—the sea breeze setting in near noon, with a great surf on the shore, and ending at 4 or 5 o'clock in the afternoon. The N.E. wind sets in toward evening, and continues during the night.

Santiago, or *Ribeira Grande*, commonly called *A Cidade*, stands at the bottom of a ravine at 6 miles to the W.N.W. of Praya. Vessels of any size can anchor before it in the fine season; the best place is said to be in 8 to 14 fathoms, with the fort flagstaff in one with the episcopal palace. From hence to the S.W. point of St. Iago there is no anchorage. Midway between this and the North extremity of the island, are *Ribeira Barca* and *Ribeira Prata*, two beaches 3 miles apart, near which are some houses. Water may be got at these anchoring places in the fine season. *Tarrafal Bay* (page 811), on the same coast, is about 6 miles northward of Ribeira Prata.

The channel between St. Iago and Fogo is deep and clear, and sailing vessels are recommended to keep near mid-channel to avoid the calms and currents to leeward of St. Iago. Off the North and N.E. parts of the island of Fogo the currents are much influenced by the wind, and run strongly at times.

FOGO, or Fuego, the highest island of the group, lies 30½ miles West of St. Iago. It is nearly circular in form, about 14 miles in diameter, and is only a continued volcanic mountain, rising into a peak, elevated 9,760 ft., which has been in activity in recent times, and the eruptions have sometimes forced the people to quit the island. The last eruption recorded was in 1859.* This island had, nevertheless, 15,159 inhabitants in 1884. Good water is scarce, and droughts are frequent, but, notwithstanding this, Fogo is the most fertile and best cultivated island of the group, being particularly noted for the excellence of its coffee.†

The coast is generally high and abrupt, and clear of danger within a mile of the shore, on the N.W., West, and South parts; but on the S.E., East, and N.E. parts, it is fronted by a rocky flat.‡ Light airs, calms, and squalls, frequently prevail near the land, though blowing strongly in the offing.

Porto da Luz.—*San Felippe,* the principal town of Fogo, is situated on its S.W. end, and the anchorage off it is entirely exposed to the westward, but sheltered from easterly winds. The bank is very narrow, and the bottom rocky, and at half a mile off shore a vessel will lie in *Porto da Luz* or *de N. S. da Encarnação,* in 25 fathoms, with the North point of the bay bearing N. by E. ½ E.; the South point, S.E. by S. ½ S.; and the northern battery, E. by N. ¾ N. Small vessels can anchor at a quarter of a mile off shore, in 10 to 17 fathoms. At three-quarters of a mile off, no bottom was found at 130 fathoms. The landing is bad, owing to the surf. Cattle, fruit, and corn, may be had here, but water is very scarce.

Just northward of Porto da Luz is *Porto da Villa,* another similar anchorage, in 12 to 17 fathoms, separated from it by a sandy point. This anchorage is used during the N.E. Trade season, or from November to June, and Porto da Luz during the rainy season; being dependent on the shifting of the sand, according to the season. It is high water, on full and change, at $6^h\ 15^m$; springs rise about 5 feet.

Light.—On Fort Carlotta, at the South end of the town, is shown a *fixed red* light, elevated 116 ft. above high water, but only visible 3 miles in clear weather.

The channel between Fogo and Brava is deep and clear, but the winds are generally strong in it.

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* Meteorological Office, Official Publication No. 27, page 85.

† An interesting account of "A Ilha do Fogo, e o seu Vulcao," is given in the "Boletim da Sociedade de Geographia de Lisboa," 1885, pages 376—398.

‡ A rock, with 12 to 14 ft. over it, was reported to lie about 4 miles off the North end of Fogo, with the peak bearing S. ¾ W. The sea was said to break on it, when it blows hard, and the bottom is clean all round; but its existence is very doubtful.

BRAVA, the S.W. island of the group, lies 9 miles West of Fogo. It is very high, but its peaks are almost constantly covered with clouds. Although so very high, its mountains rising one above the other, like pyramids, yet being so near Fogo it seems, in comparison, to be but low. It produces plenty of salt, and abounds most with saltpetre of any of the islands. Its climate is temperate and healthy, and for this reason the governor of the islands sometimes resides here. The winds here prevail at N.E. or East, most part of the year, excepting in July, August, and September. In 1879 the population numbered 8,156.

There are several coves and anchorages around Brava, but they are only frequented by coasting vessels, and landing is bad except in Furna Cove, on its N.E. side. Corn, cattle, fruit, and water, may be obtained in limited quantities.

Furna Cove, or the *Oven*, on the southern side of Jalunga Point, affords the best anchorage in Brava. It is landlocked, and only open to winds between S. by E. and S.W., and vessels moor to the rocks, with the anchor in about 21 fathoms. When the cove opens, the houses will be seen at its head. It is high water, on full and change, at $6^h 15^m$; springs rise about 5 feet.

Light.—On *Jalunga Point*, the N.E. extremity of Brava, a *fixed bright* light is shown on an iron support, elevated 50 ft., and visible 8 miles seaward, between N. ½ W. and S.W. ½ S.

Feijam de Augua, on the N.W. coast, is another cove, where coasters lie in 7 to 8 fathoms, sheltered from all but northerly winds.

Rombos or Romes Islets are separated from the North side of Brava by a clear channel 2½ miles wide. They consist of two irregular-shaped rocky islets, each about 3 miles in circuit, the channel between them being occupied by rocks and reefs. The western islet is lofty, and has a peak on it. The water around them is very deep.

ST. NICHOLAS ISLAND, or Sao Nicolau, lies 65 miles N.W. ½ W. from the North end of Sal, the channel between being deep and clear. It is mountainous and irregular in shape, 26 miles long N.W. by W. ½ W. and S.E. by E. ½ E., 7 miles in width at its western end, and narrowing to 4 and 2½ miles at the promontory forming its eastern half. In 1887 the population numbered 8,733. Its greatest elevation is in its western part, where *Monte Gordo* or *Olho do Mar* rises to a height of 4,415 ft., and has been seen at a distance of 80 miles. Farther to the E.S.E. is a conspicuous mountain called the *Sugarloaf* or *Peak of Trade*, elevated 2,006 feet.

Monte Gordo is composed entirely of volcanic matter, very fragile and porous, and does not form a peak like many of the smaller ones on the island. It is well clothed with vegetation, even to the summit; the *Euphorbium* flourishes to about 3,700 ft. above the level of the sea. The prospect hence is very extensive, calm, and beautiful.

The coasts are generally bold and cliffy, with but few off-lying dangers, but are subject to sudden dangerous squalls. The North coast should not be approached within 3 miles, there being no anchorage along it.

East Point is low and flat, with a pyramidal rock on it, appearing like a sail at a distance. Between East Point and *South Point*, 17½ miles to

W. ¼ N., is a large bight named *Porto Velho*, *San Jorge*, or *St. George Bay*, apparently deep and clear. At 4½ miles W. by N. of East Point is a small bay, with a black sandy beach and a pond of fresh water, supplied from the mountains, and hence called, by the English, *Freshwater Bay*, properly *Preguizo Bay*. To anchor in this bay, shut all the land to the eastward within the East point of the bay; you will then lie in 7 fathoms, within half a mile of the shore. There is good landing for boats, with plenty of good water in fine weather, and at neap tides; for, as the tide rises here 5 or 6 ft. at new and full moon, the pond is then overflowed. At this time you are subject to heavy squalls; and, notwithstanding the wind blows off shore, the sea is very high close to the beach.

Rolla Road, 11 miles W.N.W. of Freshwater Bay, is the principal place of resort in St. Nicholas Island. It may be readily known by the conical hill over it, called *Monte Formoso*, and the flagstaff on Fort Preguiça. Foul ground extends off *Krabbe Point*, the South point of the road, and it should not be approached within three-quarters of a mile. Refreshments can be obtained here, but no water, and vessels calling only for supplies are recommended to stand off and on.

There is tolerably good anchorage in 7 fathoms close to the shore; but outside that depth, or in 9 or 10 fathoms, the ground is rocky. There is a shelf stretching S.E. by S. from the N.E. point of the bay, on which less water is found than within it; so that, should your anchor start, which will happen if you are not careful, the bank being very steep, and the squalls very sudden, it may hook this shelf and be lost. The marks to anchor in about 13 fathoms, distant 2 cables off shore, are the Sugarloaf Mount bearing N.W. ½ N., and appearing over the cove or landing-place for boats; the fort, N.W. by W.; and Sugarloaf Peak, N.E.

Lights.—A *fixed bright* light, elevated 128 ft., and visible 9 miles, is shown from the flagstaff near the fort. A small *fixed red* light, visible 2 or 3 miles, is shown on the central or new quay.

Tarrafal Bay lies at the head of the bight between South and West Points, and here vessels can anchor during fine weather, in 20 to 10 fathoms, about 3 cables off shore, with the coast to the southward bearing S. by W.; the islands Raza and Branca in line, bearing N.W. ¾ W.; and the landing-place East, distant a quarter of a mile. The custom-house is situated in the S.E. angle or corner of this bay. Here, about a quarter of a mile inland, is a high rocky bluff, below which low, stony, gravelly, and, in some places, shingly ground, extends to the pebbly beach. On each side of this bluff is a very deep gully, out of which come violent flaws or gusts of wind; and, therefore, when anything of a hard gale blows, it is very difficult to turn up into this bay. To avoid these flaws, you must anchor right against the point, between the gullies, where you may ride very easy under its lee, in from 16 to 3 fathoms.

Within the bay the depths are 12, 13, and 14 fathoms, soft ground; and then they shoalen gradually to the shore, to the depths of 4 to 5 fathoms, where you have again sand to the pebbly beach. By digging a well, almost anywhere on the low land, you may water here, unless the rainy season has failed; but there is always water in the valley, about half a mile from the sea, whence the natives will bring it down on asses for a trifle. From this road you may see, in clear weather, all the leeward islands; but if it be in the least hazy, even Raza Island is not discernible.

Between Tarrafal Bay and West Point, the coast is fronted by a bank of soundings, with from 40 to 20 and 35 fathoms at half a mile from shore. In the last depth there is anchorage in calm weather, on sandy ground, at 1 mile S.W. ½ S. from West Point, but sheltered only from the N.E.

Light.—On *Ponta do Barril*, or *West Point*, is a red iron building 20 ft. high, showing a *fixed bright* light, elevated 39 ft., and visible 10 miles seaward, between S. by W. ¾ W. and N. by E. ¾ E.

North-West Bay, 2 miles beyond West Point, is only suitable for small craft, and inland, to the eastward, is the village of Praya Branca, at the foot of *Mount Martines*, which attains an elevation of 3,414 feet. Rocks extend half a mile off *North Point*, which is high and cliffy.

Praya Branca is a village of about thirty stone-built houses, thatched with reeds. The scenery here, being on the side of a stupendous mountain, is picturesque and magnificent. A small stream of water supplies the village; bananas and papayas are planted on the borders of the brook; cassada and vines on the banks of the valley. The bread is made from maize, and from farinha, or flour of cassada. The natives are, in general, poor, but very courteous.

The channel between St. Nicholas and Raza is deep and clear, but the currents are said to be very irregular. At 8 or 10 miles to the northward, H.M.S. *Swallow* experienced a set of 2½ miles an hour to the S.W., in May, 1862.

Raza, Branca, and Santa Lucia, are three small islands lying between those of St. Nicholas and St. Vincent. Rugged and mountainous, they partake of the general character of the other islands.

Raza Island, 8½ miles W.N.W. of the West end of St. Nicholas, is 2 miles long, East and West, and 1½ mile wide, with steep cliffy shores, inaccessible except in very fine weather, and attains an elevation of 316 feet. In the old charts it is named *Chaon* or *Isle of Dogs*. The best place to land is on the N.W. side, but there can be no inducement, as the island is uninhabited and destitute of water.

The channel between Raza and Branca is said to be encumbered by a coral reef, at about one-third over from Raza, lying S.S.W. and N.N.E., and having 6 fathoms on its shallowest part, but deepening gradually on the West to 15, and on the East to 18 and 20 fathoms. The sea was said to continually break over the reef, owing to a strong tide or current setting through between the isles, but its existence is doubtful.

Branca Island, the *Redonda* of the old charts, lies 3 miles N.W. of Raza, and is 2 miles long, N.W. and S.E., but only half a mile across where widest. It can only be landed on in fine weather, and, like Raza, it has no fresh water. The S.E. part is low and sandy, with a breaking spit extending off it, but near the centre the island rises to an elevation of 978 feet.

The channel between Branca and Santa Lucia has depths of 9 to 12 fathoms in it, but the South and East sides of the latter should not be approached within 1 mile.

SANTA LUCIA ISLAND, or Santa Luzia, 3½ miles North of Branca, is 6½ miles long, N.W. and S.E., by 1 to 2½ miles in width, its shore nearly everywhere rocky and inaccessible. Its eastern end has some high hummocks on it, separated from the hills in the western part by low land. Its greatest elevation is 1,209 ft., near the centre. The South coast trends E.S.E. and W.N.W., 3½ miles, and in a cove near the middle of it is a good landing-place; a steep bank, half a mile wide, stretches all along it, having 2 to 4 fathoms on its edge. The island is uninhabited, and frequented by fishermen only. There are many turtle here, and much orchilla is gathered, with some cotton, in a wild state.

Near the middle of the bight formed by the S.W. side of Santa Lucia is *Leon Islet.* Between this and South Point are the ruins of a village and a well of good water, three-quarters of a mile from South Point, and small vessels can anchor off the sandy beach in fine weather, in 8 to 15 fathoms, sand and pebbles.

The passage between Santa Lucia and St. Vincent is named *Foul Channel,* and in blowing weather, with the tide setting to windward, the sea sometimes breaks, giving the appearance of shoal water, but H.M.S. *Leven* beat through, and did not find less than 6 fathoms, with 15 fathoms in mid-channel.

ST. VINCENT ISLAND, or San Vicente, 4½ miles N.W. of Santa Lucia, is 12½ miles long, E.S.E. and W.N.W., and from 3 to 7½ miles in breadth. It is composed of two ranges of volcanic mountains, separated by a wide valley running S.E. from Porto Grande, through the central part of the island. It has numerous sharp peaks, and *Green Mountain,* the highest part, rises to an elevation of 2,483 ft. near the centre of its N.E. side. The coast is generally high and rocky, with but few off-lying dangers, and forms a number of small bays and coves, some with sandy beaches.

The population of St. Vincent numbers about 5,500, chiefly fishermen and labourers at the coaling depôts at Porto Grande. The climate is said to be healthy, but water is very scarce, being dependent on the rains. There is but little vegetation, owing to the deficient rainfall, and the great force of the winds. The wind blows generally from the N.E.; in the rainy season, which commences in the month of July, and ends in the middle of October, the S.E. wind prevails.

The N.E. coast of St. Vincent forms two bays, separated by a low peninsula, and this coast has been described as altogether dangerous. The East and S.E. coasts are fronted by off-lying rocks, but the South coast appears free from danger. Captain Bartholomew states that on the eastern side of the island is an anchorage, called the *Praya da Gatta,* with a sandy beach, and he says that vessels may anchor in 6 fathoms; the bottom is clear, but a sea sets directly in when the wind is either N.E. or S.E., the Island of Santa Lucia sheltering between these points. This bay and coast are without wood, water, and inhabitants.

Still Bay, about 2 miles N.W. of the South point, affords anchorage near its centre in 20 fathoms, ooze and sand, with regular soundings from the ship to the shore, and very good landing on the beach.

San Pedro Bay, on the South side of West Point, is described as having a fine sandy beach, and in fine weather vessels may anchor in 10 fathoms near the middle of the bay, or rather more to the westward. The anchorage is good in the dry season, and the inhabitants say there is plenty of wood and water. The American whalers frequented this place. The telegraph cable from St. Iago is landed here.

West Point Lighthouse is a square stone tower, completed in 1894. It is proposed to exhibit a *flashing bright* light, giving four or five flashes every minute, at an elevation of 175 ft., and visible 16 miles.

Porto Grande, on the N.W. side of St. Vincent, is the most frequented port of the Cape Verde Islands, numerous South American and West African mail and other steamers calling here for coal. The bay is 2 miles wide between *Ponta da Ribeira Julian,* on the E. by N., and *Ponta do Morro Branco,* on the W. by S., and extends 1¼ mile within this line, with regular soundings decreasing from 14 and 16 fathoms in the entrance toward the shore. In the centre the depth is 10 to 12 fathoms. Being so spacious and easy of access, a pilot is not required for it. Sailing vessels must beware of sudden squalls from the high land, and the bay is frequented by sharks.

Passaros, Bird, or *Jow Islet,* two-thirds of a mile N.W. by W. from Ribeira Julian Point, is 300 yards long, North and South, and 150 yards wide, with a conical rocky appearance. It is steep-to all round, and forms a good mark, with its conspicuous lighthouse buildings.

The Lighthouse on Bird Islet is an iron tower, 40 ft. high, showing a *fixed bright* light, elevated 306 ft., and visible 14 miles in all directions, except where obscured by the land of St. Vincent and St. Antonio. Near the lighthouse is a *Signal Station.*

Mindello, the town, is beautifully situated on the S.E. angle of the bay, and contains about 5,000 inhabitants, mostly black. It is fronted by *Orontes Bank,* a shallow flat extending about half a mile off, with depths of 2 to 2½ fathoms, and 4 and 5 fathoms near its edge. Large quantities of coal are stored here, which is sent off in lighters towed by steam-launches, and can be put on board at the rate of 900 tons a day. Other supplies may be had to a moderate extent; the price of fresh beef was 7*d.* per pound, and vegetables 3*d.* per pound. Good water was formerly very scarce, but is now brought down in pipes from mountain springs, 8 miles inland, which yield a constant and plentiful supply. The island being almost barren, the inhabitants are dependent on St. Antonio for supplies. There is telegraphic communication with Europe, viâ Madeira; also with Brasil and the West Coast of Africa.

The climate is said to be healthy, but fever is sometimes experienced in September after the rains, and also in the Harmattan season. There is a hospital here. The quarantine station is built of red brick, on the S.W. shore of the bay, and has a pier. Vessels in quarantine are allowed to coal, under certain restrictions. Only small repairs could be effected here, but a building slip is being constructed.

A small *fixed red light,* visible from 1 to 3 miles, is shown on the Custom-house pier.

Directions.—As the Cape Verde Islands are so frequently enveloped in fog, it is advisable, in coming to Porto Grande from the northward, to make for St. Antonio, the shores of which are high and bold, rather than for the low N.E. end of St. Vincent. On a nearer approach, Bird Islet is easily made out, and the curious rocks on Columna and Botelha Points, respectively eastward and westward of the entrance of the bay.

In coming from the southward, a sailing vessel must beware of being set to leeward by the S.W. current, which is said to run weaker along the coast of St. Antonio.

There is ample anchorage ground in Porto Grande, sheltered from all quarters, but during the N.E. Trade violent squalls are of frequent occurrence, and ships should always be prepared with a second anchor in case of parting, or drifting. Vessels of 15 ft. draught may anchor at 3½ cables from the shore, but vessels of large draught are recommended to anchor farther out, to avoid Orontes Bank. A good berth for a large ship is in 10 fathoms, gravel, with Bird Islet bearing North, and the fort on the point North of the town, E.S.E. In coming in under sail, shorten sail in time, and look out for heavy gusts over the high land. If in want of coal, a berth should be picked up as near the stores as possible, where the water is smoother and the squalls less felt.* It is high water, on full and change, at 6^h; springs rise 3½ feet.

Going into Porto Grande at night, the high land all around is very deceptive, and Bird Islet and the lights are the only guides; the islet always shows clearly and distinctly, even on the darkest nights. After passing Bird Islet, bring it to bear North, and anchor on that bearing in 10 fathoms, sand, with the West point of the bay bearing W. by N.

Ships should moor with a kedge, as a very strong current commonly sets to the N.E. between Bird Islet and the shore, and, as the N.E. wind is variable, at night it is impossible to keep a clear anchor without this precaution; for the wind at times comes in strong gusts from off the land.

Telegraph Cables.—Several telegraph cables are landed on the eastern shore of the bay, marked by *beacon buoys*, painted in *black* and *white stripes*. Vessels must not attempt to anchor near or eastward of the buoys, or of a line joining Bird Islet and the fort; and at night, in coming from the northward, should not anchor until the red light on the pier comes open of Fort Point.

The channel between St. Vincent and St. Antonio is deep and clear, but the currents appear to be uncertain, sometimes running strongly to the N.E., and also eastward of Bird Islet. When H.M.S. *Challenger* was here, in 1873, the current was observed to be tidal, but considerably affected by the Trade Wind. At 3 hours before high water at St. Vincent, the current set to the N.E., and ran for 5 hours; the stream turned 2 hours after high water, and the ebb ran S.W. for 7 hours. The greatest rate was 1 mile an hour.

In working between St. Vincent and St. Antonio, you may approach as near as you please to the former, and to within 1 mile of the latter, but keeping a good look-out for the reefs S.W. of Santa Cruz. It is advisable to keep over toward St. Vincent, as there are no dangers on that side.

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* The remains of a wreck lie in 7 fathoms, nearly 7 cables W. by N. from the custom-house jetty, with Bird Island bearing North, and vessels should avoid this spot in anchoring.

ST. ANTONIO, or Santo Antao, the N.W. island of the group, lies 7 miles N.W. of St. Vincent. It is 22 miles in length. E.N.E. and W.S.W., by 10 to 14 miles in width, and from a distance appears as an assemblage of mountains, particularly to the West. A chain of high mountains occupies its central part, with numerous others on either side, of which *Sugar-loaf Mountain* attains an elevation of 7,400 ft. in the western part of the island. Several deep ravines, containing streams, run up from the coast, particularly on the S.W. and N.E. sides, and in the latter are some small villages. In 1879, the population numbered 20,507. The climate is healthy, and its soil very productive, producing coffee, sugar, wine, cotton, indigo, tobacco, fruit, &c. Goats are said to be numerous, and some salt is made. It is well wooded.

The coast of St. Antonio in most parts is high and abrupt, with but few off-lying dangers. When coming from the northward, sailing vessels should not approach the East coast within 5 miles, to avoid the calms and squalls prevailing off it.

Ponta do Sol, or *North Point,* is a low sandy projection at the foot of the cliffs, and a breaking reef extends half a mile off it. Here is a village and custom-house, the chief port of the island, West of which there is anchorage in 8 to 16 fathoms, sand, sheltered from winds between S.E. and S.W. The people say northerly winds are not felt here, being deflected by the high land. Small quantities of water may be had from a spring near the beach, but the landing is bad in rough weather.

Light.—Near the extremity of Ponta do Sol is a masonry pillar, on which a *fixed red* light is shown, elevated 23 ft., and visible 3 miles, as a guide for the anchorage.

Between North and East Points are two immense ravines, and on that to the S.E. is the village of *Pavula. East Point* has some rocks off its North and South extremes.

Light.—On *Lombo do Boi* or *Bull Point,* the North extreme of East Point, is an octagonal white lighthouse, 34 ft. high, named Fontes Pereira de Mello. The light is *fixed bright,* visible 16 miles, varied by a *bright flash* every minute, visible 27 miles, but it is said to be irregular. It is elevated 543 ft. above the sea, and stands in lat. 17° 6′ 50″ N., long. 24° 59′ 15″ W.

At 8 miles S.W. of East Point is the *Rio Janella,* a mountain stream, eastward of which there is indifferent anchorage in *Carvoeiros Bay,* off a small village. At 1½ mile farther on, vessels can anchor off *Simao,* in 8 to 11 fathoms. *Santa Cruz,* the chief village of St. Antonio, lies 4 miles beyond the Janella, but the ground off it is not fit for anchorage, and for 3 miles farther on the coast is fronted by reefs and foul ground, reaching about 1 mile off, and marked by breakers.

Tarrafal Bay, affording the best anchorage around St. Antonio, lies off the deep ravine 1½ mile North of South Point. It is only open between S.W. by S. and N. by W., and winds from these quarters seldom blow home, being deflected by the high land, but sometimes send in a swell. This is considered to be the best watering-place among the Cape Verde Islands, but no other supplies could be obtained here. A small stream, which is never dry, here descends from the mountains, and is collected in ponds or reservoirs, about 60 or 70 ft. above the sea; a sluice conducts it to a well about 50 yards from the sea. In the vicinity of the pool was a fine plantation of bananas, papayas, &c., and in the lower sandy grounds a cotton plantation with some trees.

Tarrafal Bay is spacious, with a black sandy bottom, but the bank of soundings is very steep, 40 fathoms being found at one-third of a mile off shore, whence it shoalens to 30, 20, 8, and 4 fathoms, the latter near the beach. A 6-ft. patch lies 1¼ cable N.W. ½ N. from the South point of the bay, and a bank of 4 to 3½ fathoms at 1 cable N.E. by N. from the same point. It is high water, on full and change, at 7^h; springs rise about 5 feet.

In approaching, a conspicuous white mark will be seen low down on the cliffs 2 miles North of Tarrafal Bay, and in coming round South Point beware of the current which sometimes sets towards it. The bay will be recognised by a green plantation, and a black sandy beach below the cliffs. The bank being so steep, care is necessary in coming to an anchor. A good berth is in 39 fathoms, sand, 3 cables off shore, with a red mark on the cliff bearing E. by S.; 20 fathoms is found about 1½ cable nearer in.

7.—THE BERMUDAS, OR SOMERS ISLANDS.

These islands lie 570 miles S. 71° E., *true*, from Cape Hatteras, and received their name of Bermuda from having been discovered, about the year 1503, by Juan Bermudez, a Spaniard, in the vessel *La Garza*, though bad weather prevented the crew from landing. Attention having thus been called to their existence, they were occasionally visited by passing vessels, but no attempt was made at colonisation.

The name of *Somers*, by corruption *Summer Islands*, originated thus:—In 1609, an English fleet of nine vessels left London to convey the newly-appointed Governor, Sir Thomas Gates, Admiral Sir George Somers, and other officials, to the young colony of Virginia. On St. James' day, July 24th, reckoning themselves within seven or eight days' sail of Cape Henry, they encountered a dreadful storm, by which the fleet was dispersed. One of them, the *Sea Adventure*, with Sir George Somers on board, was severely damaged, and after five days suffering the crew sighted land, and ran their ship ashore at these islands, where she became a complete wreck. Having saved most of the stores, they contrived to build a pinnace, the *Patience*, and on May 10th, 1610, they set sail, and reached Fort Algernon in safety, but they found the Virginian colony so badly off for provisions that Sir George Somers volunteered to return to Bermuda for supplies; shortly after landing he died near the site of the present town of St. George, where there is a monument erected to his memory. His nephew, Capt. Matthew Somers, then carried his uncle's embalmed body to England in the old cedar pinnace. Owing to Captain Somers' representations, a company was formed in England to colonise the islands, and in 1612 the first settlers arrived under the charge of a carpenter, afterwards Governor Richard More.*

Since that time Bermuda has been a British colony, and latterly an important naval and military station. The defences of these islands demonstrate the great importance attached by the parent country to this colony as a place of refuge for merchant ships in time of war, a rallying point for our navy, a depôt for provisions and naval stores, and as a sheltered security for refitting and repairing vessels of almost any size, for which there is an enormous iron floating dry-dock.

The present chart is founded on the survey by Captain Thomas Hurd, R.N., 1783—1797, to which additions and corrections have been made by later surveyors.

The islands occupy the S.E. side of an extensive coral reef, which is of an oval form, comprised within the parallels of 32° 13½′ and 32° 29′ N., and the meridians of 64° 38′ and 65° 2′ W. It thus covers an extent of 22 miles E.N.E. and W.S.W., with an average breadth of 10 miles, and its peculiarities will be best understood by a reference to the chart. Its northern, eastern, and western edges are all covered at high water, but at low water a ledge dries here and there. The only exception is North Rock, which shows 8 ft. above high water. The outer band of reefs encloses a lagoon, with innumerable patches, separated by depths of 10 to 12 fathoms and under, with several anchorages near the islands, but only approachable by a limited number of navigable channels, and for these experienced pilots are necessary.

The islands extend over a length of 13 miles, but are nowhere more than 1½ mile in breadth, and for a large part are very much less. The large islands, five in number, are Bermuda, containing the town of Hamilton; St. George, with its town of the same name; St. David, Somerset, and Ireland Islands. Besides these there are numerous inhabited islets, with reefs and rocks, as shown on the chart. Their combined area amounts to 12,378 acres, or about 19½ square miles, or less than Guernsey. Being low, with a dull and sombre aspect, the islands are difficult to make out in foggy weather; their greatest elevation is 260 ft., at *Sears* or *Starss Hill*, one-third of a mile S.E. of Flatt's village, on Harrington Sound, but by far the greater part forms gentle undulations reaching only from 20 to 60 ft. above sea-level, partly covered with cedar or juniper trees and various shrubs, with patches under cultivation. Though the land generally is so low, yet there are many parts, such as

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* Among the chief recent authorities which have been referred to for the ensuing description of these islands, we may mention the account by the late Sir Wyville Thomson, the well-known naturalist of the *Challenger* Expedition, appearing in "Good Words" for February and March, 1874; the stay of H.M.S. *Challenger* at the islands lasted 36 days. For later information we are chiefly indebted to "An Account of Bermuda, Past and Present," by John Ogilvy, M.A., M.D., Surgeon-General, 1883; "The Bermuda Islands, with the Coral Reefs," by A. Heilprin, Philadelphia, 1889; "Reisebeschreibung der Plankton Expedition," by Dr. O. Krümmel, 1892, pages 80—104; and to the Annual Government Reports. The early history of the islands is exhaustively treated by Major-General J. H. Lefroy, in his "Memorials of the Bermudas or Somers Islands, 1511—1687," 2 vols., 1877.

Gibbs Hill, *Mount Langton*, and the North parts of *St. George* and *St. David Islands*, which may be seen in clear weather 15 miles off.

When first discovered, the islands were covered with forests of a variety of cedar. Even now only about one-sixth of the area is cultivated, the remainder being hilly or stony ground, or extensive marshes. The principal crops raised are early vegetables, such as potatos, onions, lily bulbs, tomatos, and beet-root, for the New York and other markets, which cause a brisk business in the months of April, May, and June. Arrowroot —the starch of *Maranta arundinacea*—is excellent, and fetches a much higher price than the West Indian arrowroot, which is driving it out of the market. Bermuda was famous for its oranges, but about the year 1854, the trees became infested with a minute insect, which ultimately caused their complete destruction. Fruit is by no means abundant, but includes bananas, melons, lemons, oranges, grapes, figs, and other subtropical varieties. The smaller English fruits—gooseberry, raspberry, currant, &c.—run to wood, and do not bear, but strawberries fruit fairly. Vegetables of all descriptions are easily grown, of excellent quality, but are not largely cultivated. There is comparatively little live stock on the islands; cattle and sheep do not thrive well, probably mainly owing to the want of a plentiful supply of good water. Butcher's meat is almost all imported from America. Horses are not very numerous, and only tolerably good; there are a few mules and asses. Fish is abundant, and in great variety.

The composition of the islands being white granular limestone, it absorbs the sea-water, and if a well be sunk in almost any part of the islands it is filled with water at once, but it is only the upper layer which is fresh. The water at the bottom of the well is brackish, and is affected by the tide, and the fresh water, which is merely the rain-catch of the surrounding ground, lies on its surface. As there is always a certain amount of mixture, the wells do not yield good drinking water, and the people trust greatly to their rain-water tanks. It has become an almost universal custom to roof the houses with thin slabs of white limestone, and, further, to whitewash both roof and walls. The rain-water collected on the roof, kept clean and fresh by the constantly renewed whitewash, is carefully led into tanks, and forms the only supply of pure water.

At the census in 1891, the civil population numbered 15,013, of whom 5,690 were white; the military and naval forces averaged 3,076. The coloured element is by no means entirely African. In the earlier days of the settlement, many labourers and slaves were brought from Virginia and other parts of North America; and one may often recognise the aquiline nose and characteristic features of the North American Indian, now, however, except in one or two families, very much marked by negro intermixture.

This colony cannot be considered a wealthy one, being dependent mainly on the military and naval establishments, and on agriculture. As before stated, its main trade is in the export of vegetables, which in 1892 were valued at £107,728. The old island shipping industry is now a thing of the past. A good deal of money is put in circulation by winter visitors from America and elsewhere, Bermuda being within four days' steam of New York. There is regular communication with New York, Halifax, and Jamaica, and in 1890, the islands were connected with the telegraphic system by a cable to Halifax.

Supplies of various kinds can be obtained here, but are not plentiful, and there is no public market. Rain-water costs about one-farthing a gallon. *Coal* is stored in considerable quantities, at Grassy Bay, Murray Bay, and St. George's.

The Climate of Bermuda, according to Governor Sir R. M. Laffan, has long been celebrated for its mildness and salubrity. The thermometer generally ranges from 45° to 55° during the winter months, and it is only on very rare occasions that it goes down to 40°. There is never anything approaching to frost, and flowers, fruit, and vegetables are more abundant in the winter and spring than in summer. The summer, on the other hand, is never characterised by any extreme heat, the thermometer seldom rises higher than 85°, and the heat is generally tempered by a sea breeze; but the prevailing breezes during the summer months blow almost invariably from the S.W., and arrive at Bermuda heavily charged with the vapour of the Gulf Stream, and in consequence of this the summer atmosphere is almost always extremely damp and heavy, and most people find it enervating and depressing.

Some remarks on the Winds and Weather of Bermuda have been given previously, on pages 169—170. We may here add the figures derived from fourteen years daily observations, those from 1872—1879, and from 1881—1886.* The total number of observations taken during that period was 9,130, distributed as follows, among the eight principal points.

North.	N.E.	East.	S.E.	South.	S.W.	West.	N.W.	Calm.
795	1352	352	1204	590	2729	844	976	288

From November to May the weather is mild and agreeable, but in June it becomes hot and sultry, and long droughts are frequent. This lasts till September, when it becomes cooler.

During the summer months, from April to September, the winds prevail from S.S.E. to S.W.; thermometer, 80° to 84°. About the latter end of September the northerly winds set in, when the thermometer falls to 70° and 74°; quite a bracer for the constitution. In winter, northerly winds sometimes blow hard for two or three days together, with a cool dry atmosphere. Sometimes, however, South and S.W. winds have been known to prevail during most part of the winter months.

The mean temperature, as deduced from 10 years daily observations, is 71° F., while that of Madeira, in almost exactly the same latitude, is 65¾°; this difference of 5¼° being probably owing to the effect of the above-mentioned S.W. winds. The warmest month is August, averaging 87°, and the coolest February, averaging 55°. The average annual rainfall is 56 inches, evenly distributed thoughout the year. Judging from General Lefroy's careful statistics, Bermuda cannot be regarded as an essentially unhealthy place, or as one possessing a climate unfavourable to the life of

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* "Meteorological Observations at Foreign and Colonial Stations of the R. E. and A. M. D., 1852—1886," published by the Meteorological Council, 1890.

Europeans. The death-rate among the white population is about twenty-two in a thousand—nearly the same as the general death-rate of England, and the number of people of advanced age is large.

These islands appear to lie in the zone of variable winds, northward of the Trades, and also in the track of Hurricanes pursuing a normal course from the Tropics, which have occasionally caused fearful destruction. Revolving gales are frequent, especially in the winter. Farther on, we give Sir W. Reid's observations upon these storms.

The *Bermuda Squalls* are sudden and violent tempests, occurring particularly in the winter season. As the day closes, the whole horizon becomes obscured by dark and heavy clouds, and the thunder and lightning, which precede the first squall, give notice of its approach. After the commencement, the wind, continually shifting, blows in tremendous gusts at intervals of every 20 or 30 minutes, a dead calm intervening; and the sea, rising in confused and breaking waves, renders the situation of a vessel, particularly a small one, very dangerous.

The conduct pursued by seamen, and which appears to be the most advisable under such circumstances, is to furl the ship's sails, and endeavour to get before the wind; by which means she may ultimately run clear of these local squalls into a steady breeze. It is an observation made by seamen who are familiar with the Bermuda Islands, that the various winds which blow meet there and contend for superiority; and the inhabitants themselves remark, that the *Currents* about their rocks are as variable as the winds, and numerous as their islets.

Tides.—It is high water, on full and change, at about $7^h\ 15^m$; springs rise 4 ft., neaps 2 or 3 ft., but the rise is affected by the winds, being highest with northerly winds, and lowest with S.W. winds: it frequently rises 6 or 7 feet. In the offing the flood sets N.E., and the ebb S.W., but near the shore the set is in various directions.

The Currents are very variable, both in strength and direction, being greatly influenced by the wind. Caution is therefore necessary in making the islands in thick weather.

Pilots can be obtained off St. David Head by signalling, and their assistance is absolutely necessary for vessels passing within the reefs. The government pilots may be known by a narrow blue burgee, with a broad arrow in white thereon.

There are four *Signal Stations*. One on Fort Victoria, at St. George's; one at Mount Langton, near the Governor's house, near Hamilton; another on Gibbs Hill, near the lighthouse; and another at the dockyard, on Ireland Island. Signals can thus be transmitted from one part of the islands to another, and vessels requiring pilots, &c., will be telegraphed.

The REEF.—This singular tract, 22 miles in length, E.N.E. and W.S.W., with a greatest breadth of 11 miles, forms an effectual barrier against the fury of the Atlantic storms, being, with the exception of the few narrow and intricate entrances, an impenetrable line of reefs and breakers, over which no vessel can pass. It is composed of whitish limestone and sandstone, in many parts as if composed entirely of minutely pounded shells, and calcareous clay, resembling pipe-clay. Upon this, coralline structures grow in innumerable patches, and in every variety. It is to this circumstance that the great danger in navigating within the reef consists.

The water on the reef is remarkably clear, so that even small objects are readily distinguishable at considerable depths. A dollar may be discerned at 16 or 18 ft.; and the appearance of the bottom, in many parts, in clear weather, is very beautiful, from the varied growth and structure of the coralline productions. To this circumstance of the transparency of the water, the pilots owe their talent of conducting vessels through the mazes of the reef. Taking an elevated position in the ship, up the shrouds, in the top, or on the forecastle, they direct the course of the vessel by the appearance of the bottom; brown or discoloured patches indicate coral and reefs. And it must be insisted on, that only the practised eye of the Bermudian pilots can be depended on for conducting a ship safely.

The outer border of the reef is shallower than the centre, many parts having less than 1 fathom over them. Within this external and rocky barrier, which may average about a mile in breadth, the coral rocks raise their heads in countless numbers, with depths of 5 to 10 fathoms between them. There are some large tracts clear from shoals, as that to the N.W. of Murray Anchorage, with depths of 7, 8, and 9 fathoms.

In 1879, the officers of H.M.S. *Flamingo* took careful series of soundings to determine the distance to which the 100-fathoms line of soundings extends from the northern and western edges of the encircling reefs. The depth gradually increases from 6 or 8 fathoms, close-to, to 30 and 35 fathoms, and then suddenly to no bottom at 100 fathoms. Thus, on the East side, the 100-fathoms is found at 3 miles distant from the reef; on the South side, at 1¼ mile; off the S.W. extremity, about 5 miles; and on the North and West sides, at 2 to 3 miles.

It is thus seen that the depth increases with extreme rapidity. At 7 miles N.N.W. of North Rock there is a sounding of 1,370 fathoms. At 10 miles off the N.E. side of the reef, are soundings of 1,530 and 1,260 fathoms; at 7 miles off the S.E. side, 1,240 fathoms; at 6 miles to the South, 1,325 and 1,075 fathoms; at 6 miles to the West, 1,950 fathoms; and at 10 miles to the N.W., 2,100 and 1,710 fathoms. The abruptness and isolation of this peak, which runs up a solitary cone to a height above the bed of the ocean about equal to that of Mont Blanc, is certainly unusual; probably the most reasonable hypothesis may be that the kernel is a volcanic mountain, comparable in character with Pico in the Azores, or the Peak of Tenerife.

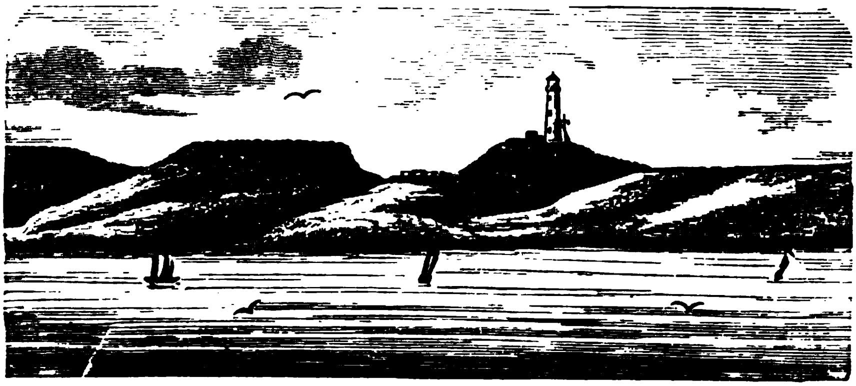
Off-lying Banks.—The only direction in which there would seem to be a series of detached banks is along an extension of the axis of the reef to the S.W. H.M.S. *Challenger* anchored for a night in 30 fathoms water on this line, about 20 miles from the edge of the reef, and Argus Bank lies at a still greater distance in the same direction. The following particulars of these coral banks are derived from examinations made by the officers of several of H.M. ships. They abound with fish, such as snappers, and large rock-fish.

Challenger Bank, sounded over by H.M.S. *Challenger*, in May, 1873, appears to be about 5 miles in diameter within the 100-fathoms line, with general depths of 24 to 30 and 40 fathoms over it, coral bottom, and very steep-to. From the depth of 24 fathoms, on its N.E. edge, Gibbs Hill lighthouse bears N.E. by E. ½ E., distant 13½ miles, with great depths between.

Argus Bank.—In June, 1829, H.M.S. *Columbine* anchored on the N.W. part of this bank, in 35 fathoms, 24½ miles S.W. by W. from Gibbs Hill lighthouse, and in April, 1836, H.M.S. *Larne* found a depth of 28 fathoms in the same locality. In 1879, H.M.S. *Argus* found this bank to lie about 5 miles S.W. of Challenger Bank, with a depth of 580 fathoms midway between; she anchored in 30 fathoms on the eastern edge, 24 miles S.W. of Gibbs Hill lighthouse, and found the currents weak and irregular, on one occasion setting S.E., at the rate of three-quarters of a mile an hour.

Argus Bank appears to be about 6 miles in diameter within the 100-fathoms line, with general depths of 20 to 30 fathoms over it. The least water found by the *Argus* was 10 fathoms, over brown coral, 26 miles S.W. ½ W. from the lighthouse; but in 1893, H.M.S. *Pelican* found only 8 fathoms on this spot, so that the coral is probably rapidly growing to the surface. In bad weather the sea would be likely to break on it. From this outer bank the land is not visible.

GIBBS HILL LIGHTHOUSE is a most useful landmark for vessels approaching the Bermudas from the West and S.W. It is a round iron tower, 130 ft. high, and painted white; when seen by day, from a distance, it will appear like a sail. It stands on the summit of the hill, which is elevated 245 ft., near the S.W. end of Great Bermuda, in lat. 32° 15′ 4″ N., long. 64° 49′ W. (see page 76). The light is *revolving bright*, attaining its greatest brillancy once every minute, at an elevation of 362 ft. above high water, and visible 24 miles.



Gibbs Hill Lighthouse and Telegraph, bearing N.E. by N.

The light is visible in all directions, except towards the N.E., where it is obscured by higher land between N. 50° E., and N. 54° E., and between N. 55° E. and N. 64° E., a ray of light appearing between these sectors over Mills Breaker. It is therefore invisible over Ship Channel and its approaches, for which St. David's light is the guide by night.

In coming from the eastward, Gibbs Hill light should not be brought to bear southward of W. by S., when less than 15 miles distant, nor should it be approached nearer than 6 miles on this bearing. In coming from the westward, it should not be approached nearer than 10 or 12 miles, until it bears to the northward of N.E. by E. With the light bearing westward of North, the reef lining the coast nowhere reaches three-quarters of a mile off, and it may be safely approached within 3 miles. Any vessel getting sight of the light from the northward and N.E. had better haul off immediately, as the reefs reach from 8 to 16 miles off between those bearings.

As above stated, the Reef lining the S.E. sides of Great Bermuda and St. David's nowhere reaches more than three-quarters of a mile off, but the outer edge is one continued line of breakers, many of which are dry at low water. When Gibbs Hill lighthouse is brought to bear westward of North it begins to increase in width. Nearly 2¼ miles S.W. by W. from the lighthouse, and more than 1 mile off shore, with Wreck Hill bearing N. ¾ W., is a spot which always breaks, called the *South-West Breaker*, and hence the edge of the Reef trends W.N.W. towards the South end of *Long Bar*, which lies 5 miles W. by S. from Wreck Hill (pp. 832, 833). Hence it rounds gradually to the North and N.E., as a continuous and very dangerous rocky flat, the shoaler patches on the *Western Ledge* being known as the *Chub Heads*, 6 miles W.N.W. of Wreck Hill.

Near the northern edge of the Reef is *North Rock*, 20 ft. long and 6 ft. wide, three gray pinnacles united at their base, and reaching 8 ft. above high water, at 7 miles N.W. by N. from Fort Victoria. From North Rock, the Reef rounds gradually to the East and S.E., and then turns toward the N.E. side of St. George Island.

Being so steep-to, many parts of the Reef are marked by breakers in bad weather. At night, or in thick weather, when a vessel is known to be in the vicinity of this dangerous area, the lead must be kept constantly going and carefully attended, not approaching into less than 14 fathoms.

Channels.—There are several narrow and tortuous passages through the Reef, of which that most used is Ship Channel. The various channels, having different directions, are available according to the wind, that which is fair for one being the reverse for others; but they must not be attempted without a pilot. Care must be taken to avoid all brown or dark patches, which are coral rocks, with little water on them.

ST. DAVID'S LIGHTHOUSE, standing on *Mount Hill*, forms a good landmark for vessels approaching Ship Channel from the N.E. It is an octagonal white tower, 55 ft. high, showing a *fixed bright* light, elevated 208 ft. above high water, and visible 20 miles, between N.W. ½ N. and S.W. ½ W., being obscured by land to westward. To N.W. by N. it is obscured over a small arc by the land about Fort Victoria.

SHIP CHANNEL takes a general N.W. direction, and passes about half a mile off the N.E. sides of St. David and St. George Islands, with depths of 6 to 10 fathoms, but is so encumbered with coral patches, as to be impassable without the aid of buoys. Both the entrance and the *Narrows* are marked by *buoys* arranged on the uniform system, those on the starboard hand, entering from seaward, being *conical* and painted *black;* and those on the port hand are *can* buoys, painted in *black* and *white chequers.*

The *Outer buoy* is a *black and white chequered can,* surmounted by a pole; it lies in about 5 fathoms, near the N.E. extremity of the reefs off St. David Island, with Fort Cunningham bearing W. ½ S., distant 6¾ cables, and St. David Head, S. by W. ⅝ W. At 2 cables N.W. ¼ W. from this is the *Fairway chequered buoy,* the entrance of the channel passing between the latter and the *Outer black conical buoy,* about one-third of a cable to N.E. It is unnecessary to describe the positions of the inner buoys, which are marked in the plan on the chart.

The flood tide sets through the Narrows, with a velocity varying from one-quarter to 2 knots an hour, and then sweeps round St. Catherine Point. The ebb sets in all directions among the reefs on the N.E. side of the channel.

Five-Fathoms Hole, Outer Hole, or *Jervis Roadstead,* seaward of the reefs forming Ship Channel, is a clear space with depths of 7 to 10 fathoms, but it cannot be considered as safe, there being no protection from the sea between W.N.W. and S.S.W., round by North. Sailing vessels, however, sometimes lie here in favourable weather, if the winds are not fair for proceeding into St. George's Harbour, or through the Narrows. A good berth, with N.W. winds, is in 8 fathoms, with the conical *Cherrystone* or *Sugarloaf Hill,* 108 ft. high, at the head of Mullet Bay, open of the old battery on the S.E. point of St. George, bearing about West; St. Catherine Point about N.W. by W. ¾ W.; Mount Hill lighthouse, appearing over St. David's Head, S.W. by S., the latter distant 9 cables, with the rocks about the S.E. end of Cooper Island seen open of it. In every part of these roads you must be guided by the eye where to drop your anchor clear of foul ground, which is everywhere easily seen, owing to the clearness of the water and whiteness of the sand where the anchorage is safe. The coral patches appear of a darker colour.

Within the reefs is the *Inner Hole,* with depths of 5 to 8 fathoms, lying between the outer patches and the reefs reaching off the N.E. side of St. David and Paget Islands. Cherrystone Hill, bearing about W. ¼ N., and seen over Town Cut, leads in from near the fairway buoys. Directions for entering St. George's Harbour are given hereafter.

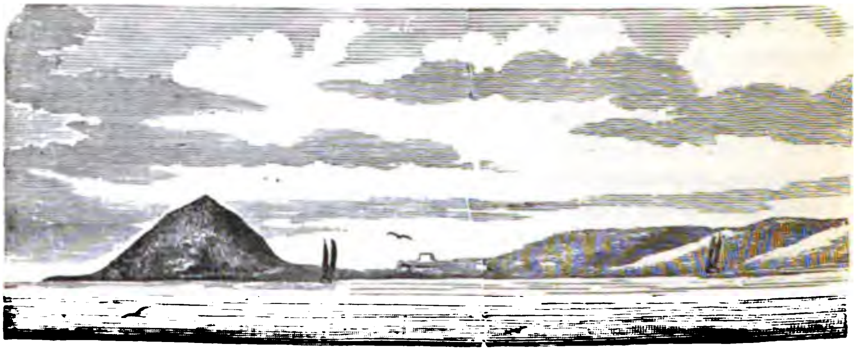
Mills Breaker Channel, only used by local vessels, is 2⅓ miles N.E. of Ship Channel, the entrance being half a mile northward of *Mills Breaker.* This is a small patch, drying at low water, 3 miles N.E. by N. ¼ N. from St. David lighthouse, and marked by a *buoy.* Within, it takes a S.W. direction toward the Narrows of Ship Channel. Between this and North Rock the Reef is impenetrable and continuous.

North Rock Channels, passing on either side of North Rock in a S.S.E. direction, are known only to a few of the pilots, and from that cause but seldom used, although it is said that the eastern channel is one of the best through the Reef. It is narrow and intricate at its entrance, with general depths of 6, 7, and 8 fathoms, but in one spot only 5 fathoms. Midway between North Rock and Murray Anchorage, lies a cluster of rocks, which render a circuit to the westward advisable. The mark for clearing the West end of these, the *Three Hill Shoals,* was Painter's Hill appearing over a hill on the western side of the Ferry at St. George's Island, bearing S.S.E. There was also a channel through the shoals, which was more direct; the mark for which was Painter's Hill, in the hollow or saddle of Two Hills (hence their name), at the West end of St. George's Island, bearing S. ½ E. As soon as the shoals are cleared in either case, which will be when 2½ miles from St. George, you can bear round to the S.E. to Murray Anchorage, this part of the lagoon being clear.

From hence to Long Bar and South-West Breaker, the N.W., West, and S.W. parts of the Reef are almost continuous, with only three known intricate channels.

West Blue Cut has its entrance about 5½ miles N. by W. from Wreck Hill. It can only be used by small vessels, being exceedingly narrow and intricate, with only 8 ft. water in places. It runs about S. by E. ½ E.

Chub Cut, the next channel to the S.W., is also narrow and dangerous. Its entrance bears N.W. by N. ½ N. from Wreck Hill, whence it takes a south-easterly direction for 1½ mile, and then branches off to the southward for Wreck Hill and Somerset Island, and to the eastward for Ireland Island.



Wreck Hill, bearing N. ¾ E.

Hog-Fish Cut, leading to Ellis Harbour and Ireland Island, passes to the N.E. between the reefs, and then turns to N.N.W. along the West coast of Great Bermuda. Its least depth appears to be 4 fathoms, and for vessels with local knowledge this channel is the most convenient at the West end of the islands, particularly in the winter season, when the winds prevail at N.W., and the danger of being at sea and about the islands is the greatest. A proposition was made, and a committee appointed, in 1846, to improve the channel by removing some of the obstructions, which would have rendered it sufficiently capacious for vessels now often compelled to remain at sea, or make the circuit of the islands in search of shelter. Nothing, however, has since been done.

In approaching Hog-Fish Cut from seaward, the outer reef and *Bream Shoals* will be crossed by keeping the two *beacons* erected on the West part of Bermuda in line, N.E. ½ N., until Gibbs Hill lighthouse bears E. ¾ S., when the channel turns to the N.N.W., following parallel with the shore at a distance of 2½ or 3 cables. The course through what are called the Chops of the Cut is nearly at a right angle; the turn is very sudden and sharp, and the greatest nicety must be observed by the pilots in navigating it. The passage is so narrow that it does not afford sufficient space for vessels to tack in, and these difficulties are felt more especially in the winter season, when the winds are generally unfavourable for passing Kitchen Shoals.

The approaches, through the reefs, to Castle and St. George Harbours, are described hereafter, and we now proceed to give a description of the principal islands.

IRELAND ISLAND, at the N.W. part of the group, is 1½ mile in length, but very narrow, less than one-quarter of a mile where widest. It is entirely occupied by the commodious Government Dockyard and Naval buildings. The Dockyard is on the northern part of the island, and is separated from the other part by a deep dry ditch. It is protected by a substantial breakwater, forming a harbour with 6 fathoms water in it, and here is an iron floating dock, 381 ft. long and 83¾ ft. wide, towed across the Atlantic from Sheerness in 1869. On the highest point of the fortification, on the North end of the island, is a flagstaff, one of the four Signal Stations established on the islands. The hospital is situated on the southern and highest part of the island, and is very large and commodious.

Time Signal.—On the western jetty of the Dockyard is a flagstaff, on which, on Saturdays only, a ball is hoisted to an elevation of 90 ft., at $11^h\ 45^m$ a.m., and dropped at noon, Bermuda mean time. Its position is lat. 32° 19′ 19″ N., long. 64° 49′ 34·5″ W., equivalent to $4^h\ 19^m\ 18{\cdot}4^s$, Greenwich mean time, but the longitude is not absolutely settled; some authorities place it about 2′ farther West (see page 76).

Between Ireland and Somerset Islands there are several smaller ones, the chief of which is *Boaz Island.* These are united by a roadway.

Somerset Island is 2 miles in length, and of irregular form, and is on the whole lower than the other islands. On *Daniel Head*, its N.W. extremity, is a *beacon*, elevated 97 ft.; an islet lies off it. Near its southern end is another *beacon*, elevated 148 feet. *Ellis* or *Elies Harbour*, lying between its southern extremity and Wreck Hill, may be reached from the Hog-fish Cut, from Ireland Point, or by the Chub Cut. Between Somerset Island and the N.W. side of the Reef the ground is all rocky, so that the channels to the harbours are very circuitous, and no directions can be given for them.

GREAT BERMUDA, or Long Island, the principal of the group, is 13½ miles in extent, varying in width from a few yards to 1½ mile, its widest part being between Hamilton and Harrington Sound. The country is undulating and well wooded, with here and there extensive brackish marshes, cumbered with luxuriant vegetation. It is intersected by good roads, and dotted with white-roofed houses, churches, and schools. On its western shore the sea is slowly hollowing out the low sandstone cliffs, and on the South the gales of winter cause the sand to encroach on the cultivated land. It has been said that much has been lost from the selfish policy of felling the large cedar trees, which once formed a barrier around this part of the island. The southern shore is the boldest among the islands, and vessels may come in some places within 2 cables of it, though it would not be advisable to attempt to do so. On the S.E. side is a large space of sand, called the *Sand Hills*, which is very remarkable.

Wreck Hill, 144 ft. high, is a projecting headland at the western extremity of Great Bermuda. It forms a good mark, being isolated by low land, conical, and very dark coloured. When seen from the S.W. it appears flattened at its summit, but from the South as peaked. It is the land looked for, and first seen, when approaching the islands from the West. A view of it is given previously, on page 832.

Gibbs Hill, the next remarkable point, lies 3 miles S.E. ½ E. from Wreck Hill, and is the highest and most conspicuous eminence observable near the S.W. part of the coast. It is a smooth mount, entirely clear of trees, with the lighthouse and Signal flagstaff on its summit. To the westward, and contiguous to it, is a table-land, which was crowned with a grove of tall dark cedars. A view of Gibbs Hill is given on page 829, where the lighthouse is also described.

Between Gibbs Hill and Castle Island, off the N.E. extremity of Great Bermuda, there are several sandy mounts, having the appearance of white cliffs, and by moonlight might be mistaken for breakers. These are very remarkable, and are called the *Sand Hills*. One of these is much more conspicuous than the others, being of greater extent, and without any verdure upon the summit. *Castle Island* lies 2 miles E.N.E. of the great sand-hill. The coast here presents a very picturesque scene of land and water, with the high land of St. George appearing over St. David Island, and the smaller islands enclosing Castle Harbour.

Hamilton, the chief town and the seat of government, was founded in 1790, and is situated on the North side of an inlet, formed by a projection on the northern side of Great Bermuda. The late Sir Wyville Thomson described it as a quaint, rather pretty little town of about 2,000 inhabitants. A half-street of regular houses and stores, with green verandas, faces the harbour, with a commodious line of wharves and sheds along the shore. The better houses are scattered and a little inland, and some very pretty villas, the residences of the leading merchants and some of the Government officials, occupy pleasant situations round the head of the bay. The suburbs show well the peculiarity of the contrast between the white-roofed houses and the dark junipers; nearly the best examples of these so-called "cedars" form a fine avenue just behind the town.

Hamilton Harbour is convenient and well sheltered, and vessels drawing 16 ft. can lie alongside the town wharf. The approaches, however, are very intricate.

At the back of the town rises *Mount Langton*, on which stands the Governor's residence, surrounded by gardens. Here also is a *Signal Station*. On the shore, to E.N.E., are the *Wells*, a government establishment for supplying water to the navy, should there be no water at the naval tanks on St. George. On an elevated plateau, about half a mile northward of the town, is *Prospect Camp*, where a large proportion of the garrison is quartered. *King's Hill* or *Clarence Lodge*, the residence of the Admiral in command, is 1¼ mile W. by N. ½ N. from Government House, and to the westward is *Spanish Point*, the N.W. extreme of Great Bermuda.

A coral ledge extends from Spanish Point to Ireland Island, separating Grassy Bay fron the inner or Great Sound. There are two passages through this ledge, by which vessels reach Hamilton Harbour. *Stag Channel* is 3 cables S.E. of the Dockyard breakwater, with depths of 2 to 2½ fathoms at low water, and is marked by *buoys*. The other channel is midway between this and Spanish Point, with about the same depth.*

Great Sound is a spacious clear area, with depths of 7 to 11 fathoms, separated from Hamilton Harbour to the East, and *Port Royal Bay* to the South, by ranges of rocky islets.

Grassy Bay, westward of the Dockyard, has anchorage and moorings for men-of-war. It is a clear space, with regular soundings of 6 to 8 fathoms, bounded by reefs, but a breeze from any direction soon raises a sea. It is high water here, on full and change, at $7^h\ 14^m$; ordinary springs rise 4 feet.

Harrington or *Little Sound* is a spacious and deep sheet of water formed by the N.E. part of Great Bermuda. It only communicates with the sea by a narrow channel at its western end, called the *Sound's Mouth*, over which is a bridge at *Flatts Village*. Through this passage the tide ebbs and flows with great velocity, but does not pass in sufficient quantity to sensibly affect the level of the water within.

Castle Harbour, the large area comprised between the N.E. end of Great Bermuda and St. David Island, is full of reefs, and is rarely entered by large vessels, though there is good anchorage. It is faced to the S.E. by the Reef, on which is a range of islets and rocks; on *Castle Island*, the westernmost, is an old castle, from which the harbour takes its name. These islets are remarkable for the colour of the cliffs and the dark verdure of the turf which covers them. The entrance, narrow and intricate, passes along the East side of Castle Island, with depths of 2 to 4 fathoms. The mark to lead across the outer edge of the Reef is *Minor Hill*, on the North side of St. George Island, midway between Castle Island and Southampton Island. As soon as this is crossed, steer to pass about midway between these two islands, and continue to the northward, and anchor in 5½ fathoms, one-third of a mile N.W. by W. from the West end of *Nonsuch Islet*.

St. David Island, the easternmost of the Bermuda group, is 2 miles long, W.N.W. and E.S.E., and on *Mount Hill*, near its S.E. point, is the *lighthouse*, previously described on page 830. *St. David's Head*, its eastern extreme, is a round rocky bluff, covered with cedars, and, when the land is opened to the northward, a large cave will appear to view beneath the head. The Reef extends only 3 cables from this bluff.

In working, from off the S.W. end of Castle Harbour, ships may stand within a mile of the shore; and small craft until the bottom is seen.

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* In 1892, the legislature resolved to spend £40,000 in improving the channels leading from Grassy Bay to Hamilton Harbour, so as to obtain a least depth in them of 20 ft. at mean low water.

Vessels waiting for pilots may run in to the N.E. of St. David's Head, and heave-to with their head off shore; the bottom is hereabouts visible, but no danger may be apprehended on that account. The pilots keep a good look-out, and delay seldom takes place.

Paget Island and *Higgs Island* lie between the N.E. end of St. David and the S.E. end of St. George Island, the channel to St. George Harbour passing between St. David and Paget Islands. *Fort Cunningham*, on the S.E. part of the latter, forms a good mark. On either side of Higgs Island is a narrow boat channel, the southern one named *Higgs Cut*, and the northern one *Town Cut*.

ST. GEORGE ISLAND, the northernmost of the Bermudas, is the military station of the colony. It is 3 miles in extent, E.N.E. and W.S.W., and in no part more than half a mile wide. In the angle formed on the southern side of its eastern end is the town of *St. George*, the site of the first settlement, but now next to Hamilton in importance. It is more prettily situated than Hamilton, and has a good line of wharves. The streets, however, are close and narrow, and the drainage is bad; so that it is by no means healthy. The marine slip can take a vessel of 1,200 tons, and repairs are efficiently executed here.

St. George's Harbour, formed between St. David and St. George Islands, is the best among the islands, being capacious and completely landlocked, but the entrance is narrow, and the bar has only 16 ft. water over it at low water. It is well sheltered from the stormy West and N.W. winds, with depths of 5 to 7 fathoms, over a bottom of stiff pipe-clay. The vicinity to the open sea alone gives it a decided superiority to the anchorage of Grassy Bay, if there were nothing else to recommend it. It is high water here, on full and change, at $8^h\ 15^m$; springs rise from 4 to 7 feet.

The Entrance of St. George's Harbour, bearing West.

The outer roadstead has been previously described on page 831. To proceed into St. George's Harbour, from the *Five-Fathoms Hole*, bring in line a stone pillar and a white stake, situated on the northern slope of St. David Island; these, bearing S.W. by S. ¾ S., will lead over the reef in 3½ fathoms least water, leaving two *black buoys* to starboard, and two *white buoys* to port. When within 1 cable of the shore, the course must be altered to the westward, as in proceeding from Boiler Channel.

Boiler Channel, the southern approach to St. George's Harbour, is very narrow, with least depths of 12 to 15 ft. in it. Its entrance passes North of *Jenkins Boiler Reef*, and about 3 cables S.S.E. of the outer buoy (page 831). Whale House, on Smith Island, in line with the old battery below Fort Cunningham, bearing about West, leads in till the leading marks on St. David Island come in line.

Still farther South is an entrance sometimes used by small vessels, running under St. David's Head, but it has not more than 9 ft. at low water. This leads in a N.W. direction.

Continuing on the same course from Boiler Channel, pass southward of a *white buoy*, and between the South end of Paget Island and Governor's Islet, the depths passed over varying from 2½ to 3½ fathoms. Here the town of St. George will open out on the starboard bow. The channel thence proceeds along the S.W. side of Paget Island, and when abreast the S.E. end of St. George Island, alter course to the westward for the anchorage, passing in depths of 12 to 15 ft. over the flat connecting *Ordnance* and *Hen Islets*, and then anchor as convenient, off the town.

On *St. Catherine Point*, the N.E. extremity of St. George, stands *Fort Catherine*, conspicuous from its isolated appearance. On the summit of the steep and wooded hill S.S.W. of it is *Fort Victoria*, elevated about 150 feet above the sea, and here is a *Signal Station*. At half a mile S.W. of this is *Fort George*, elevated 164 feet.

St. George's Island and Fort, from Murray Anchorage.

Murray Anchorage, off the North side of St. George Island, has depths of 8 to 9 fathoms, good holding ground, from the Naval Tanks and the landing-place at *Tobacco Bay*, 3½ cables westward of St. Catherine Point, to abreast the West end of the island. Ships from sea approach this roadstead through the Narrows, where the bottom, as well as over the anchorage, consists of stone, of the soft, dripstone kind, ground as fine as flour, mixed with a shelly substance and a chalky clay; it is very heavy, therefore the anchors do not sink deep in it, and they loosen immediately when a-peak, but it is rarely that ships drive in it. The best anchorage is in 9 fathoms, about half a mile off shore, with St. Catherine Point bearing East, and Fort George S.E.

A heavy sea gets up during N.W. gales, cutting off communication with the shore, and Lieut. Evans, R.N., described Murray Anchorage as "one of the most unpleasant places in the world to ride in during the winter season. I have been for several weeks riding out a N.W. gale in a frigate here, pitching bows under; and the *Driver*, a sloop-of-war, is said to have carried away her bowsprit, in consequence of its getting under the cable, when she was in the act of plunging during a gale. The *North Rock*, at about 8 miles in the offing, appears, from this anchorage, through a telescope, like a ship's boat with three lug sails."

From this anchorage to the man-of-war anchorage at *Grassy Bay*, Ireland Island, the distance is about 8¼ miles, and the least depth found in the passages between the reefs is about 5½ fathoms. In clear weather, all the reefs are readily discerned, and may be avoided with a common degree of care. If necessary, vessels can anchor in 6 fathoms, off the entrance to Harrington Sound.

From the anchorage of Grassy Bay sailing ships, unless they happen to be favoured with a leading wind, are generally one day working up to Murray Anchorage, a distance of 9 miles; and there they must wait until the wind proves fair before they can get to sea round St. Catherine's Bluff, and through the intricate channel which leads to St. David's Head. Even with a fair wind to or from Ireland Island, ships are liable to strike upon the rocky heads everywhere scattered about.—*Lieut. Evans.*

In entering or leaving the N.W. end of the Narrows, vessels must pass well to the southward of the *red fairway buoy*, which lies 1⅛ mile N.W. ½ N. from St. Catherine Point.

DIRECTIONS FOR MAKING THE BERMUDAS.

In hazy weather, or at night, vessels must be very cautious in making these islands, lest the winds or currents should set them on the reefs, or into some inextricable channel. Be particularly cautious in coming from the S.W., as many ships have been lost upon the rocks off this end of the islands. In approaching them by running down a parallel, with a large wind, and not making the land toward night, but expecting to be near it, no vessel in this situation ought to lie-to, but should rather turn to windward, under easy sail, until daylight. The land not being high, it cannot be seen at any great distance from a small vessel; added to this, the thick haze which frequently prevails here, particularly in fine weather, renders making the land somewhat difficult, and at times precarious, unless the latitude be accurately ascertained. Instances have happened of vessels missing the islands, and, after a fruitless search, steering for the American coast, in order to take a fresh departure for running down the latitude again.

Bermuda is always approached with more safety from the *southward*; and in running for it at night, or in thick weather, care should be taken not to get to the northward of lat. 32° 8′, before seeing either the lights or the land.

In running for Bermuda from the *eastward*, the best parallel is between lat. 32° 15′ and 32° 23′; in which a ship may run boldly, as here there are no rocks at any distance from the land.

The prevailing winds, with fine weather, in these seas, being from between the South and West, vessels from the West Indies and America generally make these islands by running on their latitude from the *westward*. The best latitude for that purpose is 32° 8′, always having regard to a small probable current in the direction the wind blows.

Admiral Murray recommended vessels bound to these islands from the northward and westward, when within the Gulf Stream, to steer well to southward, perhaps as much as S.S.E., until within 3 or 4 miles of the latitude of Cape Hatteras; and then steer S.E. by E. until into latitude 32° 5′. Thus you will avoid crossing the Gulf Stream where it is very broad, and its direction far to the eastward, passing it where it affects your latitude more than your longitude; and, of course, be of less consequence to the ship's reckoning. By steering thence so far to the southward as S.E. by E., you will fall into the latitude of the Bermudas at 4 or 5 degrees of longitude to the westward.

You should by no means run for these islands unless sure of your latitude; and always make them from the S.W., if possible, looking out in time for the land, as, owing to the set of the Gulf Stream, and the general tendency of the currents to the eastward, ships from the coast of America will almost always be far ahead of their reckoning. Admiral Murray says, "I recommend you to make great allowance for your being to the eastward of your reckoning, and try to fall into the parallel of latitude above mentioned, in longitude 70° or 71° W."

Having ascertained your latitude, and being well to the westward, get into the parallel of 32° 5′, and steer *true* East; this course will bring you to within sight of the islands, passing clear to the South of the western dangers. Should the wind in the night incline to the northward, keep in 32° 7′ N.; but if to the southward, in 32° 2′.

As seen from the S.W., in clear weather, when 15 miles distant, the Bermudas will appear as an assemblage of detached high islets, on the South part of which the lighthouse and signal-post on Gibbs Hill is seen, being erected on nearly the highest land in the islands.

In approaching as above from the West, you will probably first see the land about Gibbs Hill, appearing like two small sand-hills close together, distinguished by the lighthouse before mentioned. As you near the land, you will see Wreck Hill farther to the northward, appearing peaked, and joined by low land to that first seen. Steer to bring Gibbs Hill lighthouse to bear E.N.E., and, when within 6 miles of the land, take care it is not brought to the eastward of that bearing, because of the rocks called the Long Bar. Then steer so as to pass within 2 miles of the S.E. coast of Great Bermuda. When Wreck Hill shuts in behind the land, you are clear of the S.W. Breaker, and may steer along the S.E. side of the island, at 1 or 1½ mile distant from the shore, until abreast of St. David's Head.

The soundings do not extend more than 2 miles from the shore along this coast; therefore you have only a strict look-out to depend on for safety. You must avoid, by all means, running in the night, without having a good observation the preceding day, and being pretty sure of your longitude.

In the winter, with the wind from the N.E., there is a strong set to the S.W. along this coast, and it is very tedious and unpleasant to turn to windward, the wind blowing in heavy squalls at intervals.

Continue past Castle Harbour, which is easily known by Castle Island, and bring-to off St. David Head, and wait for a pilot who will soon come off, or, if absolutely necessary, anchor in the Outer Hole. When to the eastward of St. David Head, stand no farther to the northward than to bring the head S.W. You will see a white sandy bay to the southward of the head, between it and Castle Harbour; in standing to the northward, care must be taken to shut no part of this bay in behind St. David's Head. The West land of Bermuda will be shut in behind the land, over this bay, before this mark comes on.

No stranger should attempt any of the anchorages or channels without a pilot, many of whom are always on the look-out, and put to sea when a vessel heaves in sight. Their boats may be readily known, being of a peculiar construction and rig; of a light draught of water forward, with a long heel or deep sternpost; rigged with one mast and bowsprit, carrying a triangular mainsail, a foresail, and jib, and, occasionally, a gaff topsail and squaresail.

Admiral Murray says that "in case you have been driven to the eastward of the islands (a situation, however, which you are to avoid with the utmost care), you may run for them in lat. 32° 14′ N., which will bring you to them 6 or 7 miles to the southward of St. David's Head, for which you may haul up upon making the land; but you are not to run till you are far enough to the S.W. to follow the directions before given for coming from the westward, should you make sail for Bermuda from any part of the Gulf Stream or without it."

ON THE WINDS, ETC., OF THE BERMUDAS, BY COL. SIR W. REID.

The first half of a revolving gale is a fair wind from Bermuda to New York, because in it the wind blows from the *East;* but the last half is a fair wind from New York to Bermuda.

During the winter season, most of the gales which pass along the coast of North America are revolving gales. Vessels from Bermuda, bound to New York, should put to sea when the N.W. wind, which is the conclusion of a passing gale, is becoming moderate, and the barometer is rising to its usual level. The probability is, more particularly in the winter season, that after a short calm the next succeeding wind will be easterly, the first part of a fresh revolving wind coming up from the S.W. quarter.

A ship at Bermuda, bound to New York or the Chesapeake, might sail whilst the wind is still *West* and blowing hard, providing the barometer indicates that this West wind is owing to a revolving gale, which will veer to the *northward*. But as the usual track which gales follow in this hemisphere is northerly or north-easterly, such a ship should be steered to the southward. As the wind at *West* veers towards *N.W.* and *North*, the vessel would come up, and at last make a course to the westward, ready to take advantage of the *East* wind at the setting in of the next revolving gale.

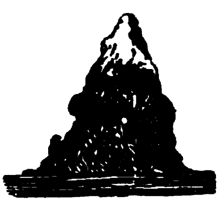
A vessel at New York, and bound to Bermuda, at the time when a revolving gale is passing along the North American coast, should not wait in port for the westerly wind, but sail as soon as the first portion of the gale has passed by, and the N.E. wind is veering towards the *North;* provided it should not blow too hard. For the *North* wind will veer to the *westward,* and become every hour fairer for the voyage to Bermuda.

A great number of gales pass along the coasts of North America, following nearly similar tracks, and in the winter season make the voyage between Bermuda and Halifax very boisterous. These gales, by revolving as extended whirlwinds, give a *northerly* wind along the shore of the American continent, and a *southerly* wind on the whirlwind's opposite side, far out in the Atlantic. In sailing from Halifax to Bermuda, it is desirable for this reason to keep to the westward, as affording a better chance of having a wind blowing at *North,* instead of one at *South;* as well as because the current of the Gulf Stream sets to the eastward.

When vessels from Barbados, or the neighbouring West India Islands, sail to Bermuda on a direct course, they sometimes fall to the eastward of it, and find it very difficult to make Bermuda when westerly winds prevail. They should therefore take advantage of the Trade Wind to make the meridian of 68° or 70° of West longitude, before they leave the parallel of lat. 25° N.

On a ship leaving England for Bermuda, instead of steering a direct course for the destined port, or following the usual practice of seeking for the Trade Wind, it may be found a better course, on the setting in of an *easterly* wind, to steer West, and if this wind should veer by the *South* towards the West, to continue on the port tack until, by changing, the ship could lie in its course. If the wind should continue to veer to *North,* and as it does sometimes even to the *eastward of North,* a ship upon the starboard tack might be allowed to come up with her head to the westward of her direct course. On both tacks she would have sailed on *curved lines,* the object of which would be to carry her to the westward against the prevailing wind and currents. There is reason for believing that many of the revolving winds of the winter season originate within the Tropics; and that ships seeking for the steady Trade Winds, even farther South than the Tropic, at that period of the year, will frequently be disappointed. How near to the Equator the revolving winds originate in the winter season, is an important point not yet sufficiently observed. The quickest voyage from England to Bermuda, therefore, may perhaps be made by sailing on a course composed of many curved lines, which cannot be previously laid down, but which must be determined by the winds met with on the voyage. This principle of taking advantage of changes of revolving winds, by sailing on curved lines, is applicable to high latitudes in both hemispheres, when ships are sailing westerly.

8.—ROCKALL, OR ROKOL.



Rockall, 2 miles distant, as sketched by Mr. Harvey.

This is a large rock, of a conical or sugarloaf shape, the summit or upper part of which is perfectly white, from the quantity of birds' dung, with which it is covered. Though it had been seen many times, its true situation was unknown till the year 1810, when it was ascertained by Mr. T. Harvey, master of the *Endymion* frigate. Together with the bank on which it stands, it was examined by Captain Vidal, R.N., in 1831, and again, in August, 1862, by the officers of H.M.S. *Porcupine*, when surveying the bank of deep soundings West of Ireland, and during which survey the Porcupine Bank was discovered.

This solitary rock, the summit of a submarine mountain, emerges from the ocean in lat. 57° 36′ 20″ N., long. 13° 41′ 30″ W., 225 miles *N.* 53° *W.*, *true*, from Tory Island, off the North coast of Ireland. It rises to an elevation of 70 ft. above the sea, is about 250 ft. in circumference at its base, and is composed of a coarse granite. The summit, sharp-pointed and whitened by birds, can only be gained from its N.E. side, and landing is at all times difficult, for it is steep on all sides. On the N.E. side, however, is a small detached rock, called *Haslewood Rock*, uncovered at half-tide, with 30 fathoms of water between it and Rockall, from which it bears N.E. by N., 1½ cable distant. The lowest estimate that was formed of the range of the tide, judging from the appearance of the rock, was 6 ft.; but this seems large for a tide-wave in mid-ocean.

N.E. Dangers.—On April 19th, 1824, the brigantine *Helen* struck on a small rocky patch, estimated to lie about 6 miles (perhaps less, the weather being hazy,) E. by N. ½ N. from Rockall; the vessel ultimately foundered. The sea broke occasionally on the rocks, but no other breakers were in sight at the time.

When Rockall bore N. by W., the officers of the *Endymion* saw broken water appearing about 1 mile to the N.E. of it; and, on approaching nearer, a rock, on which the water broke, appeared just at the water's edge. When due South of Rockall, the breakers were in a line with the eastern part of it. The sunken rock bore N. 73° E. from it, at least 1¾ mile distant. It was considered that this rock was probably that on which the *Helen* was lost.

Captain Hoskyn, H.M.S. *Porcupine*, stated that *Helen Reef* bears S. 79° E.,* 2 miles, from Rockall, has about 6 ft. over it at low water, and is very dangerous. Its situation is generally shown by its breakers, but towards high water, and in very fine weather, it only breaks at long intervals; being small and steep-to, there is then nothing to indicate the approach to it. To avoid it, keep Rockall clear of a W. by N. bearing. There is a safe passage between it and the rock.

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* It will be noticed that there is a considerable discrepancy in the positions given by the various surveyors. Captain Hoskyn's description is contained in the "Nautical Magazine," 1862, pages 564—565, but it is not stated whether his bearings are magnetic or true.

Other observers have reported that rocks extend about 3 miles to the south-eastward of Rockall, on which the sea broke occasionally.

Rockall Bank is sometimes frequented by fishing vessels. Within the 100-fathoms line it is about 70 miles in extent, E.N.E. and W.S.W., and 20 to 30 miles in width, its greatest breadth being on the parallel of 57° 30′ N. The northern edge is in 57° 55′ N., but soundings under 200 fathoms extend 20 miles farther to N.N.E. Its S.W. edge is in 56° 55′ N., but soundings under 200 fathoms extend far to the southward, to about lat. 55° 10′ N., long. 15° 40′ W.

The eastern and western sides of the bank are steeper, and depths of 1,200 to 1,380 fathoms have been found between it and the bank off the N.W. coast of Ireland.

9.—SABLE ISLAND, OFF NOVA SCOTIA.

This singular and dangerous island, lying 85 miles S. ¾ E. from the lighthouse on White Head Island, the nearest part of Nova Scotia, is fully described in the Sailing Directions accompanying the Chart of the S.E. Coasts of British America, and some remarks have been previously made upon it, on pages 438—439. It is apparently formed by the agency of conflicting currents, and has been wasting away at the western end for many years past, sometimes almost imperceptibly, and at other times several miles have been swept away during a single heavy gale.

Sable Island is formed of two nearly parallel ridges of sand, shaped like a bow, concave to the northward, and meeting in a point at either end. Its whole length, following the curve, and including the dry parts of the bars, is 22 miles, or 20½ miles, W. ¾ N. and E. ¾ S., in a direct line across the curve; its greatest breadth is exactly 1 mile. In some parts it is wholly or partially covered with grass and small shrubs; in others, scooped out by the winds into crater-shaped hollows, or thrown up into hills, the highest reaching an elevation of 75 ft. above high water. The ridges enclose a large lake of salt water, said to be gradually filling with blown sand, but still in some parts 12 ft. deep, extending from the West end to the distance of 11 miles; a low valley continues from it 6½ miles more to the N.E. end of the island. The entrances to this lake have been closed for many years, the sea flowing in over the low sandy beach on the South side, and at the West end, only in high tides and during heavy gales. Fresh water is to be had almost everywhere, by digging down a few feet into the sand. There are numerous wild horses and rabbits, and the residents keep some cattle. Fish is very plentiful.

Numerous disastrous wrecks have occurred here, and a Humane Establishment was founded in 1804, for rendering assistance to the crews of vessels in distress, and is still maintained by the Canadian and English Governments. Two lighthouses act as warning beacons by night, and each of them answers also as a house of refuge, a day beacon, a signal station, and a look-out house. Every means, including lifeboats, rockets, &c., are kept in readiness. The chief buildings are on the North side of the island, about 2 miles eastward of the West Point lighthouse, and here is a flagstaff surmounted by a crow's-nest, 100 ft. above the sea.

East Point Lighthouse, about 1 mile within the eastern extremity of the island, is an octagonal tower 86 ft. high, painted alternately white and dark brown. It shows a *fixed bright* light, elevated 128 ft., and visible 17 miles. Its position is lat. 43° 58′ 30″ N., long. 59° 46′ W.

West Point Lighthouse has had to be removed several times since its establishment in 1873, owing to the encroachment of the sea. It is a white octagonal wooden tower 98 ft. high, and now stands about 2½ miles within the western extremity of the island, and 14 miles W. by N. ½ N. from East Point lighthouse. It shows a *group-flashing bright* light, elevated 118 ft., and visible 16 miles; three separate flashes, each at intervals of half a minute, followed by 1½ minute eclipse, together occupying 3 minutes.*

The beach is usually faced by shallow ridges of sand, causing heavy breakers, dangerous for boats, when there is much sea. The landing is in general impracticable on the South side, excepting after a long continuance of northerly winds; and on the North side boats can land only in southerly winds and fine weather; but there are surf-boats at the establishment, which can land when ordinary boats would swamp instantly.

From each end of the island reaches a long shallow ridge, called Bars, which break in bad weather. The *East Bar* extends 13 miles to E. ½ N., to the depth of 10 fathoms, but in fine weather the inner 4 miles are dry. The *West Bar* extends over 20 miles N.W. ½ W., to the outer depth of 10 fathoms. Thus, Sable Island and its submerged bars form a crescent, concave towards the North, 53 miles in extent, E.S.E. and W.N.W. Vessels should be careful not to be caught within this crescent in a strong gale from the northward, when the accelerated ebb tide, setting directly towards and over the bars, would render her situation extremely dangerous. Both the bars are extremely steep on the North side, the East Bar especially so, having 30 fathoms water close to it. To the southward, on the contrary, the water deepens gradually out for so many miles, as to render it difficult to account for the greater number of shipwrecks having occurred on that side of the island and its bars, excepting by a neglect of the lead.

In approaching the anchorage off Sable Island from the northward at night, or in thick weather, the lead should be kept constantly going, and after passing the Middle Ground, between 34 and 50 miles to the northward of the island, great caution should be used, and the vessel should be certain of her position; for the East end of the island and the East Bar are very steep on that side.

There is good anchorage in 5 to 10 fathoms, fine sand, 1 to 2 miles off the North side of the island, but it is not safe with on-shore winds.

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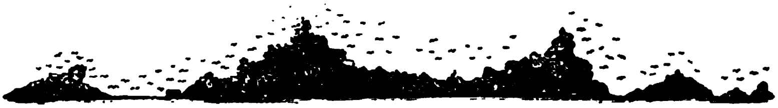
* *Fog Whistles* were formerly sounded, at the lighthouses, but were discontinued in 1878, being considered of little or no service.

Vessels seldom anchor off the South side of the island, because of the prevailing heavy swell from the southward; but they may safely approach by the lead on that side, taking care not to get becalmed in the heavy swell, and in the strong and uncertain tides and currents near the bars.

It high water on the North side of Sable Island, on full and change, at about $7^h\ 30^m$, and on the South side an hour earlier; springs rise 4 feet. The tidal streams are much influenced by the wind. The ebb sets to the southward over the bars, often running 1¼ or 2 knots an hour; the flood runs at a much lower rate, in the contrary direction.

10.—PENEDO DE SAN PEDRO, OR ST. PAUL'S ROCKS.

These remarkable rocks, which appear to have been raised by volcanic agency, lie in lat. 0° 55′ 30″ N., long. 29° 22′ 30″ W., about 515 miles *N.E.*, true, from Cape San Roque, the nearest point of the American continent, and one-third of the distance toward the Gambia on the African coast. The group consists of a cluster of four larger rocks, and ten or twelve smaller ones, all steep and craggy, without verdure, and whitened with bird's dung. They are arranged somewhat in the form of a horseshoe, forming a small cove on their N.W. side, off which H.M.S. *Challenger* was made fast by hawsers to the rocks. They occupy a space of 2¼ cables N.E. and S.W., and 1¼ cable wide, and the highest peak, on the N.E. side, is elevated 64 ft.; two other prominent peaks are of 5 or 6 ft. less elevation. The rock is composed of minerals allied to serpentine.*



The rocks change materially in their appearance, according to their bearing. The sketch annexed was forwarded to us by the intelligent master of a merchant ship.

In clear weather, these rocks are visible from a distance of 12 miles, and usually make like three sail when first seen; when closer, and bearing N.W. or S.E., they appear in the form of three sharp pinnacles on a heap of rugged rocks. Sir C. Wyville Thomson says:—"We were greatly struck with their small size, for although we knew their dimensions perfectly well—rather under a quarter of a mile from end to end—we had scarcely realised so mere a speck out in mid-ocean, so far from all other land." They are extremely dangerous at night, the lead not being of the slightest use in their vicinity.

There is no fresh water; during the calm season rain probably falls in considerable quantities, but the clouds of spray produced by the constant beating of the sea against the weather shore would make the water brackish. Excellent fish are to be obtained in great abundance, and during the season (November) the supply of sea-birds' eggs would be unlimited. Parties attempting to land must beware of the sharks.

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* The most recent account of these rocks is that given in the "Narrative of the *Challenger* Expedition," vol. i., pp. 201—209. See also the Rev. A. Renard's "Report on the Petrology of the Rocks," in the "Narrative," vol. ii., Appendix B.

The only outlying danger discovered was a rock half a cable West of the S.W. point of the cove; the least water found on it was 5 fathoms, but there may be less. With this exception, the West shore of the S.W. islet, which is readily distinguished by the most southerly and whitest hillock of the group, is steep-to. Off the West side of the most northern of the three islands, forming the North side of the cove, the rocks, with about 2 fathoms on them, shelve off into deep water 20 yards from the shore; it cannot, therefore, be approached quite so closely. At 100 yards off there is a depth of 104 fathoms.

The small bay or cove is 170 ft. across at the entrance, and about 100 yards deep, with from 10 to 5 fathoms of water, but constant rollers, produced by the south-easterly swell recurving round the points, enter the bay, and, meeting the continuous streams which enter from the south-eastward, as each wave breaks on the weather shore and pours its volumes of water through the chasms separating the islets, produces a confused sea. In reasonably fine weather a landing can always be obtained immediately inside either point of the bay. During the S.E. Trade Wind, a ship will ride easily and securely with hawsers secured one on each side of the entrance of the bay.

Admiralty FitzRoy, of H.M.S. *Beagle*, remarks:—"From the highest point of the rocks, which is 64 ft. above the sea, no discoloured water, nor any breaking of the sea could be discerned, apart from the place itself; and from the soundings taken in the boats, as well as on board the ship, I conclude that it is unconnected with any shoal, being merely the summit of a steep-sided mountain rising from the bottom of the ocean. A slight current was setting to the westward, not amounting to a mile an hour."

The Equatorial Current here sets to the W.N.W., at from 1 to 2 miles an hour. During the stay of H.M.S. *Challenger*, in August, 1873, the current was constantly running to the W.N.W.; the water, banking up and accumulating against the weather side of the rocks, rushed past each end at the rate of at least 3 knots an hour, causing a confused sea, and an eddy tide-race under the lee of the land. The boats were unable to pull against it, on trying to get to windward of the rocks.*

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* *Sandré Rock* was reported in 1849, by Captain Sandré, of the ship *Francois Casimir*, to lie about 70 miles South of St. Paul's Rocks, or in lat. 0° 14′ S., long. 29° 18′ W. He saw it about 7 p.m., December 30th, appearing as a "large black mass." Next day he saw the Penedo de San Pedro. Its existence is extremely doubtful, and it has been removed from the charts.

11.—THE ROCAS.

This low coral reef is, perhaps, the most formidable danger in the Atlantic. It is the only one of its character in that ocean—a true atoll, isolated from all surrounding lands, so many of which are found in the Pacific. It is, moreover, more redoubtable from its lying in the midst of strong and, at times, devious currents, in what, under Captain Maury's advice, has become a great highway across the Equator. Therefore, although not strictly within the North Atlantic Ocean, we consider it desirable to give a short description here, referring the reader for a complete account to Findlay's "Directory for the South Atlantic Ocean."

This very dangerous reef, which has been the scene of so many sad wrecks, was surveyed in April, 1852, by Lieut. Lee, in the U.S.S. *Dolphin;* in November, 1857, by Captain J. H. Selwyn, H.M.S. *Siren;* and in 1858, by Lieut. Vital de Oliveira, of the Brasilian Navy. The centre of the N.W. islet is in lat. 3° 51′ 30″ S., long. 33° 49′ W., 80 miles W. by N. from the peak of Fernando Noronha, and 130 miles N.E. by E. from Cape San Roque. The reef is about 5 miles in extent East and West, by 3 miles North and South, and is all covered at high water, with the exception of Grass and Sand Islets on the West, and some scattered rocks on the South and East sides. At low water these islets are from 10 to 18 ft. above the reef, which is formed of coral, generally level, though with many holes in it. On the northern islet are the lighthouse, a refuge house 40 ft. high, and several sheds. If a vessel strike on the weather or S.E. side of the reef, the chance of saving life would be but small. In clear weather, the breakers may be seen from aloft when about 10 miles off; then the two low islands and the black rock soon appear. Sea-birds abound, but there is no wood, or fresh water. There is bad anchorage, from 1 to 2 miles N.W. of Sand Island, in from 15 to 18 fathoms, coral bottom. There is also anchorage, in 8 or 9 fathoms, sand and coral, about half a mile off the N.W. part of the reef, protected from the swell. There is good landing on the reef, abreast and to leeward of the northern islet, from three-quarters ebb to one-quarter flood, and at high water just southward of the islet. Lieut. Lee found coral bottom at 15 fathoms, 6 miles East of the reef, but no bottom at 30 fathoms at 2½ miles to N.N.E., nor at 70 fathoms at 4 miles S.E. of it.

The lagoon, in which many turtle were seen, has from 1 to 4 ft. water at low tide, and shows white from the mast-head at 4 or 5 miles distance.

Lighthouse.—The Brasilian Government is erecting an iron lighthouse on this reef, and pending its completion a *fixed bright* light, visible 9 miles, is shown from a mast 49 ft. high, on the North island of the reef, about 1 mile from its N.W. edge.

The *Currents* in the vicinity of the Rocas are very powerful. It lies in the strength of the great southern branch of the Equatorial Current (pages 347—353), which sets strongly to the *westward*, but certainly not invariably in that direction, and with a very changeable rate. It is stated to run westward 1½ knot per hour, 36 miles per day. Undoubtedly this velocity is frequently attained, but it is very much less than this as a mean. In the months of September and October it is about 16½ miles a day. From a mean of about fifty observations in their immediate vicinity throughout the year, it is about 19¾ miles per day. But this rate is in varied directions; it frequently ceases altogether, or is almost inappreciable. It is found running to the South and S.E. as well as to the northward, and Admiral Roussin mentions a special case of his own experience, when he was drifted 350 miles to the *eastward*, in what is usually considered to be the strength of the Equatorial Current, at a few degrees to the eastward on the same parallel.

Under these circumstances, it behoves every commander to be specially on his guard when in the neighbourhood of this dangerous reef, especially by night, for then the only visible sign of its existence will be the breakers on its edges, should the light not be exhibited.

Lieut. J. E. Parish partly examined the reef, in H.M.S. *Sharpshooter*, March, 1856. He reported as follows:—

"On March 5th, I sighted the Rocas from the mast-head at 4h 15m p.m., bearing W.N.W., about 9 miles distant, at which time we had no bottom with 46 fathoms. I then bore up N.W. to close the group, and sounded at 5h p.m. in 13 fathoms, coral bottom, the rocks not being even then in sight from the deck. I therefore determined to remain near that position during the night, and consequently anchored in 12 fathoms, the highest rock being then first visible from the deck, bearing West (*true*).

"At 6h 40m a.m. the next day I proceeded under steam to the N.W., giving the shore a berth of about 5 miles, until arriving on the N.W. side of the sand-banks, where I anchored in 20 fathoms, coral bottom, at about 2½ miles from the shore, with the following *magnetic* bearings (variation 10° W.): the southern extreme of the breakers, S. 15° E.; the middle of the sand-banks, S. 27° E.; the highest rock of the group, S. 42° E.; and the eastern extreme of the breakers, S. 50° E.

"Whilst describing the semicircle, our soundings were 13, 14, and 15 fathoms, until the group bore S. by E., when there was no bottom with 70 fathoms. From this it appears that the shoalest water exists on the eastern side. A careful attention to the deep-sea lead would alone betray to a vessel in doubt the vicinity of the shoal on approaching in that direction, when, if practicable, anchoring is a course to be strongly recommended, until daylight or clearer weather enables the master to ascertain his true position.

"As the prevailing winds in that quarter will always enable a vessel bound North to choose a course either to the East or West of this shoal, I do not see that any master would be justified in endeavouring to sight the same; a proceeding that might be attended with considerable danger, and the benefits to be derived from which I am at a loss to conceive.

"The highest part of the bank may be set down at about 10 ft. above high-water mark. We found the current to set W.N.W. (*true*), between 1 and 2 miles per hour."

It appears probable, from the observations of Lieut. Parish, that a bank of soundings extends from the Rocas in a N.E. direction to the distance of about 5 miles. Upon this bank the depth obtained was 14 and 15 fathoms. It is strongly recommended to make a frequent use of the lead when approaching the reef, and to have an anchor and cable ready for letting go, should occasion render it necessary.

According to Lieut. Oliveira's survey, soundings of 11 to 20 fathoms are found all round the reef, at distances varying from half a mile to 1 mile from its edge. In very fine weather, the lagoon can be entered by boats, by a passage through the N.E. side of the reef. On the S.E. edge is a rock, rising 12 ft. above high water. It is high water, on full and change, about $5^h\ 15^m$; springs rise 10 feet.

Captain Dumaresq, of the *Innisfail*, in 1872, was of opinion that nothing of the reef could be seen on a fine night at a mile off, unless from the whiteness of the water on the reef and lagoon.

12.—FERNANDO NORONHA.

This island is also more fully described in Findlay's "Directory for the South Atlantic Ocean." It is used by the Brasilian Government as a convict settlement, so that stringent regulations control all communications between vessels and the shore. The island is about 4½ miles long N.E. by E. and S.W. by W., and 1½ mile wide, fertile and well wooded, and on its N.W. side rises the *Pyramid* or *Peak*, a rugged barren pinnacle 1,014 ft. high, in lat. 3° 50′ 10″ S., long. 32° 25′ 30″ W.

The town is situated between the Peak and the N.E. point, and off it is the road or principal anchorage, sheltered by the north-eastern land, and several islets in that direction. The depths are from 10 to 12 fathoms, loose sandy ground, at about half a mile from the citadel point, or nearest shore. It is unsafe to lie here with northerly or N.W. winds, which are said to prevail from December to April; in the other months the winds are mostly from the S.E. or easterly, sometimes at N.E.

Off the N.E. point lie several islets and rocks, the outermost named *Wooding* or *Rat Islet*. Other rocks lie around the island, as shown on the chart, the most distant being a rocky patch, at 1¾ mile S.E. of Tobacco or South Point, with 9 to 15 fathoms between. The sea always breaks on it, and when on it the Pyramid is shut in by the highest hill, on the South side.

On approaching the island no soundings will be found till very close in. There is no danger but what may be seen, excepting the above rocky patch, and the rocks off the S.W. point.

At Fernando Noronha, the Dry Season lasts from January to July, and the Wet Season prevails during the remainder of the year.

CAPE SAN ROQUE, in lat. 5° 29′ 15″ S., long. 35° 15′ 18″ W., is considered as the turning point of the Brasilian coast. The *Shoals of San Roque* extend between the cape and *Toiro* or *Touro Point*, 23 miles to the N.N.W., at a distance of from 4 to 6 miles off shore, the outer edge being in some places awash. The N.W. point is 5 miles N.N.E. from Point

Toiro, and the S.E. end 4½ miles N.E. from Cape San Roque. There are several channels through this outer line of reefs, and within it is a channel of 3½ to 5 fathoms throughout, except a *bar* of 13 to 14 ft. midway between Cape San Roque and Point Toiro. The chart will show the peculiarities of this important point.

13.—THE COASTS OF BRITISH AMERICA AND THE UNITED STATES.

For a complete description of the Coasts of Newfoundland, of the Gulf and River of St. Lawrence, the Coast of Nova Scotia, &c., to Cape Cod, the reader is referred to the "British American Navigator," published by the proprietor of the present work. The navigation thence to the southward, including the West Indies, is described in the Sailing Directions accompanying the Charts.

The American navigation, in general, requires details so minute, and explanations so copious, as to render it impracticable to do justice to the subject in an abridgment. It will, therefore, not be attempted. A few remarks on the principal ports only will be given, and full descriptions of the numerous Lighthouses and Coast Fog Signals will be found in Findlay's "Lighthouses of the World, and Coast Fog Signals."

In the Sections on Winds, Tides, Currents, and Passages, the various phenomena which control the Passages across the Atlantic are recited, and with those remarks are many concerning the proper mode of approaching the ports. In connection, therefore, with what follows, these previous directions may be incorporated.

The NEWFOUNDLAND BANKS, which have been, in their fisheries, the source of all the opulence in the island of Newfoundland, are vast submarine elevations, of various depths and very unequal figures. The depths on the Great Bank vary from 15 to 80 fathoms; the quality of the bottom varies considerably, but it generally consists of sand, or sand mixed with shells and gravel, rarely with stones. The eastern face of the bank is clear sand, white or whitish, and often sparkling. In the gullies and deeps which separate the banks, and more particularly in the Whale Deep or Trou de la Baleine, the bottom is found to consist of mud or oaze with a fœtid smell, and abounds with different sorts of fish, but more particularly cod, which is inconceivably numerous; for, although from 200 to 400 vessels have been annually freighted with this article of commerce for upwards of two centuries, there appears to be no sensible decrease of the former plenty. A great swell and thick fog usually indicate the position of the bank.

There are generally, in the spring, within 350 or 400 miles of the land, and between the Outer and Grand Banks, numerous Icebergs, or ice-islands, which float down with the current from the north-westward, and which, during foggy weather, are very dangerous. In the months of June, July, and August, there are frequently a number of them, some of which may be seen aground, in 40 or 50 fathoms of water. In thick weather, their position may commonly be distinguished by the *ice-blink*, a brightness of the sky above them; or by the breaking of the sea against them, which may also be heard at a considerable distance; or by the decrease of the temperature of the water. (See Section on Ice, pages 441—454).

Virgin Rocks.—On approaching toward Cape Race, the S.E. point of Newfoundland, be careful to avoid Virgin Rocks, a dangerous reef, lying 87 miles S.E. ½ E. from that cape. In gales of wind a heavy sea breaks over them; and a strong current, which sets about them, often increases the danger. The bank, on which the shoal stands, extends N.N.E. and S.S.W., 7 miles, being 1¾ mile across in its broadest part. The soundings are regular, from 28 to 30 fathoms, but deepen suddenly on the outer edge to 39 and 43 fathoms.

The *Main Ledge*, or the rocks themselves, is in lat. 46° 26′ 57″ N., long. 50° 47′ 40″ W. They extend in an irregular chain, S.W. by W. and N.E. by E., 800 yards, varying from 200 to 300 yards in breadth. The least depth of water is 3 fathoms, on a white rock, with 5 to 6½ fathoms around it, the bottom distinctly visible. Nearly 1 cable N.N.E of this is a 4-fathoms rock, and at 2¼ cables W. by S. from the 3-fathoms rock is one of 5½ fathoms. Between these three rocks the depths are from 8 to 10 fathoms.

South Shoal, 1⅓ mile S. by W. from the Main Ledge, though with deeper water, is reported by the fishermen to be more dangerous than the Main Ledge, the mass of uneven ground causing the sea to rise more readily, and break more heavily, than on the small pinnacles described above. The shoalest water found was 4¾ fathoms, and two other rocks, with 5 fathoms water over them, bear N.N.W. from this rock, the farthest being distant 1½ cable. The bank occupies a space 6 cables long and 3½ cables wide, with depths less than 20 fathoms.

These shoals are the only dangers on Virgin Rocks in ordinary bad weather, but several others are reported to break in autumnal gales, and the uneven ground, with the tidal streams about the shoals, produce a confused sea even in strong breezes. The currents hereabout are described on pages 436—437.*

The Flemish Cap, *the Outer or False Bank,* lies about 120 miles eastward of the N.E. part of the Grand Bank, with irregular depths of 689 fathoms and under between, over bottom of hard sand. Within the 100-fathoms line it appears to be about 50 miles in extent, North and South, by 15 to 20 miles in width, the least depth hitherto found on it being 58 fathoms, sand and stones, on its eastern side, in lat. 46° 54′ N., long. 44° 40′ W. The 500-fathoms line reaches nearly 60 miles eastward of this, and then the depth rapidly increases to 2,000 fathoms and over; it deepens much more quickly to the southward of the bank.

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* In 1845, Jesse Ryder, master of the fishing schooner *Bethel*, announced that he had discovered a rocky patch of 3 fathoms, in lat. 46° 29′ N., long. 49° 41′ W., or about 50 miles eastward of Virgin Rocks, which latter rocks he afterwards saw. During the survey of 1879, a whole day was spent in searching for it, but no trace of it was found, either by variation in the soundings, or changes in the quality of the bottom. The depths in the locality were from 35 to 37 fathoms, over sand and shells.

Bertel Bank, reported to lie in lat. 44° 43′ N., long. 49° 52′ W., was also carefully searched for, but no sign of it was found. The depths near the position were from 27 to 29 fathoms, over sand and shells.

The masters of various fishing vessels, who have had many years experience on the Great Bank of Newfoundland, stated that, to their knowledge, no trace of shoal ground exists near the reported positions of Jesse Ryder Rock and Bertel Bank.

Ships bound to St. John's are recommended to keep on the parallel of 46°, or 1½° to the southward of the parallel of that port, until they approach the outer edge of the Great Bank; and, when they obtain soundings, to steer directly to the north-westward for Cape Spear; but refer, also, to pages 539 *et seq.*

The HARBOUR of ST. JOHN, the principal harbour of Newfoundland, is an excellent one, and was surveyed by Captain Orlebar, R.N., in 1862, and by Commander G. Robinson, R.N., in 1885. The entrance is through the *Narrows*, a strait running in a N.W. ½ W. direction, about half a mile long, and 1½ cable across in the narrowest part, with rocky precipitous heights of 500 feet on each side. There is from 9 to 16 fathoms of water in the middle of the channel, with tolerably good anchorage ground. The harbour then opens by a turn at right angles, and runs in a W. by S. direction for 1 mile, and in front the city of St. John appears rising up the hills forming the North side of the harbour. In close proximity to Fort Townsend, now dismantled, is seen the Roman Catholic Cathedral, the English Cathedral, the churches of the Kirk and Free Kirk of Scotland, and the Wesleyan and Congregational Chapels. The ridge of hills on the S.E. side of the harbour rises to an elevation of 760 ft., and on the opposite side of the Narrows is a continuation of the same ridge, called *Signal Hill*, 508 ft. high, to which place all vessels are telegraphed from Cape Spear on their first appearance off that place.

On the North side of the inner part of the entrance to the harbour is a rock called *Chain Rock*, which, with *Pancake Island* on the opposite shore, contracts the entrance at this part to less than 200 yards; and between them a chain used to be stretched to prevent the entrance of any hostile fleet. There are batteries on the more prominent points of the Narrows, *Fort Amherst* on the South Head, and *Frederick's Battery*, 2 cables to the north-westward. Opposite to the latter, on the North shore, is the *Queen's Battery*, on a hill 390 ft. high; and on the point adjacent to the Chain and Roby Rocks is *Chain Rock Battery*.

Time Signal.—On Signal Hill a *Gun* is fired daily at noon, St. John's mean time, equivalent to 3^h 30^m 43^s Greenwich mean time. Its position is lat. 47° 34′ 2″ N., long. 52° 40′ 47″ W.

Lights.—At Fort Amherst is a stone lighthouse, 39 ft. high, showing a *fixed bright* light, elevated 134 ft., and visible 12 miles. A *Gun* is fired every hour during daylight, in thick weather, and a *Horn* is sounded in reply to a vessel's signals.

Two fixed red lights, one placed near the Custom-house, at 76 ft. above the sea, the other near the Congregational Chapel in front of the Cathedral, 174 ft. above the sea, and 400 yards apart, in line, bearing N.W. ¾ W., lead through the Narrows, but over Merlin Rock, on which there is a depth of 27 ft. at low water.

The *City of St. John*, containing about 30,000 inhabitants, is the principal settlement, and the only considerable town in the island, being the seat of government and the bishopric, and the chief port of resort. It extends along the western shore quite to the head of the harbour, and has an extent of more than a mile of water frontage, which is chiefly remarkable for its fishing stages.* The head of the harbour to the S.W. is a shallow lake, on the eastern side of which is the Admiralty yard, &c., with a dry dock, 600 ft. long, 66 ft. wide, having 25 ft. water over the sill at ordinary spring tides. Lower down the harbour is a floating dock, capable of raising a vessel of 300 tons. Supplies of various kinds, including coal, can be readily obtained. The wharves are provided with every convenience for dealing expeditiously with cargo, and there are facilities for the repair of vessels and machinery.

The entrance of St. John's Harbour is readily known by the block-house and *Signal Station* on Signal Hill on the North Head, and by Amherst Fort with its light on the South Head. A sunken rock, called the *Vestal*, lies one-third of a cable S.E. of South Head, with only 12 ft. of water on it, about 20 yards long and 14 yards wide; the marks for it are, Chain Rock Battery, open of South Head, bearing N.W. by N. ½ N., and the outer *Wash-ball Rock* on with Cuckold's Head, N.E. ½ E. Wash-ball Rocks join the North Head, and are all above water and steep-to, therefore not dangerous.

The mid-channel course in the Narrows is N.W., with a black diamond-shaped mark near the shore in line with the centre cross of the Roman Catholic Cathedral. Pass midway between *Chain Rock* on the North, and the *Pancake* on the South side; both these rocks are above water, and nearly steep-to, About 50 yards S.W. by W. ½ W. from Chain Rock is *Roby* or *Salisbury Rock*, with a depth of only 18 ft. at low water. *Merlin Rock*, which has been blasted to 27 ft. least water, lies in mid-channel, about midway between Roby and Prosser Rocks. At 100 yards within Pancake Rock, on the South shore, lies the *Little Pancake*, a rocky shoal, dry at low water; and 1 cable within the latter lies a sunken rock, called *Prosser Rock*, running off one-third of a cable from Cahil Point, in the form of a saddle, with 11 ft. of water in the hollow, and only 5 ft. on the outside; it is steep-to, with 5 fathoms close to it. After you have passed Prosser Rock you may stand to either shore, as they are clear and steep-to.

Within the harbour you may anchor in any depth from 4 to 12 or 14 fathoms, muddy bottom, landlocked from all winds, the water shoaling gradually inwards. It is, however, to be noticed, that there is no possibility of sailing in, unless with the wind from S.W. by S. to East; the wind from S.W. to N.E. by N. blows out of the Narrows. Here ships must then anchor or warp in, for which purpose there are rings in the rocks on both sides, or procure the aid of a steam-tug.

It is high water in the harbour, on full and change, at $7^h\ 30^m$; spring tides rise 4 ft., neaps 3½ feet. It sometimes rises 7 or 8 ft., being greatly influenced by the wind. In the Narrows the streams run half a knot an hour.

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* The Custom-house was destroyed in the disastrous fire of July, 1892, when nearly the whole of the wharves and buildings along the city front were consumed.

At three-quarters of a mile S.E. by E. from South Head is the North end of a narrow rocky bank, having 15 fathoms over it, and which breaks in rough weather. It extends nearly a quarter of a mile N.E. and S.W., and has on it, near each end, a depth of 20 fathoms.

Be very cautious, if unacquainted with the coast, not to mistake the place called *Quidi Vidi* (or *Kitty Vitty*), a mile to north-eastward, for the Harbour of St. John, as it shows an opening like a good harbour, but it is fit only for boats, and not safe even for these at low water. Fort Amherst and Signal Hill will point out the Harbour of St. John. Besides these, the course from off Cape Spear is N. by W., and the distance about 4 miles.

CAPE SPEAR LIGHTHOUSE is a white building, 38 ft. high, the roof painted in red and white stripes. The light is *revolving bright*, attaining its greatest brilliancy once every minute, elevated 264 ft., and visible 22 miles. In foggy weather, a *Horn* sounds a blast of 7 seconds once in every minute.

CAPE RACE LIGHTHOUSE is 40 ft. high, and is striped red and white vertically on the S.E. face. The light is *revolving bright*, attaining its greatest brilliancy once every half-minute, elevated 180 ft., and visible 19 miles seaward, from E.N.E., round southward, to W.S.W. In foggy weather, a steam *Whistle* sounds a blast of 10 seconds in every minute.

A conical *beacon* stands 50 yards South from the lighthouse, and a *Telegraph Signal Station* 240 yards North of the lighthouse. Passing vessels can communicate with it, and be reported by telegraph to St. John's. Signals are also shown in April and May, as to the prevalence of Ice in the River and Gulf of St. Lawrence.

The land about Cape Race is comparatively low, and bare of wood, with a steep cliff about 50 ft. in height. As a landfall it is somewhat dangerous on account of the fogs to the eastward, and in the season of Ice-drifts the bergs and fields are frequently very numerous about it (see page 442). A southerly course may therefore be preferable. On this topic the following remarks by Captain Orlebar, R.N., are important:—

"Although the current between the Grand Bank and Newfoundland commonly sets to the W.S.W., sometimes at a rate of nearly 1 mile an hour, it is not always so, and near the shore, in moderate weather, it even *changes with the tide*. At these times, during the flood, it runs to the S.W., and during the ebb to the N.E., the former being the stronger. Westward of Cape Race, it must also be remembered, that the current so frequently setting to the N.W., 1 mile an hour in the offing, is not invariable in strength or direction, but is affected greatly by the prevailing wind. It is observed generally to run in upon the eastern side of the great bays indenting the South coast of Newfoundland, and out on their western side. In the offing it is influenced by the winds, and near the shore it is also altered and influenced by the tides; so that during spring tides the stream of ebb runs weakly to the S.E., and the stream of flood to the N.W., the latter sometimes 2 miles an hour round the headlands.

"Vessels coming from the eastward in thick weather, if sounding carefully, will probably strike *Ballard Bank*, which lies parallel to the shore, and about 15 miles long, varying from 1 to 5 miles across. A careful comparison of the soundings thus obtained with those on the chart, will show the position of the vessel with sufficient accuracy to enable the navigator to round Cape Race without danger.

"For instance, if after sounding in about 80 fathoms, one cast of comparatively shoal water, that is from 30 to 40 fathoms, should be obtained, and afterwards the depth increases to 40 fathoms, it may be concluded that the vessel has passed over the narrow part of Ballard Bank, and is to the northward of the cape, and the course should be changed accordingly. But if shoal water, under 30 fathoms, continues for 5 miles, and then deepens slightly, and again becomes shoal, the vessel may be safely concluded to be on the southern part of the bank, and therefore South of Cape Race, and her course to the westward may be continued with confidence.

"A vessel from the westward in thick weather may round Cape Pine and Cape Race with perfect safety, if only attention be given to the lead. The water shoals gradually to the shore, and at the distance of 10 miles there is not more than 40 fathoms, so that maintaining a depth of more than 30 fathoms no risk can be incurred (see below as to this).

"It is to be regretted that there is no well-marked difference in the nature of the soundings off these headlands that would show the position of a vessel, the bottom being generally rock, with shells of the sea-egg, gray sand, and small stones predominating."

When in this locality, however, caution must be exercised to avoid *Lamb Rock*. This danger, known to a fisherman, was only announced in 1889, when he pointed out its position to the officers of H.M.S. *Gulnare.* It lies 22½ miles S. by W. from Cape St. Mary, and about 21 miles W. ¼ N. from Cape Pine, consisting of a pinnacle with 5¼ fathoms over it, and 10 to 30 fathoms close around it. The sea breaks on it when there is a heavy swell.

Nickerson Bank, another rocky patch, with 10¼ fathoms least water, was discovered in 1891. It lies 17½ miles W.S.W. from Cape Race lighthouse, and from it Cape Pine lighthouse bears N. ½ W. Within the 20-fathoms limit the bank extends 2½ cables N.W. and S.E., and it probably breaks in heavy weather. Mr. Nickerson, the fisherman who discovered it, stated that other patches of 11 and 12 fathoms lie between this and Lamb Rock.*

Cape Pine Lighthouse, 19 miles N.W. by W. ½ W. from Cape Race, is an iron tower 56 ft. high, painted in red and white bands. The light is *fixed bright,* elevated 314 ft., and visible 24 miles seaward between E. by N. and N.W. At a short distance westward of it is the famous *St. Shot's Bay,* alluded to in the account of the wrecks in (435), page 436.

The *Currents* hereabouts are described on pages 435—440; the *Winds* on pages 213—216; and the *Tides* on pages 282 and 290—292.

A general description of the *Passages* towards Newfoundland, and into the Gulf of St. Lawrence, is given on pages 539—544.

The Southern Coasts of Nova Scotia are fronted by off-lying banks of soundings, as shown on the chart, of which the most extensive are

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* In 1881, the captain of the Norwegian barque *Anna Delices,* reported that he sounded in 5 fathoms, mud, 75 miles to the S.W. (true) of Cape Race. Nothing more is known of it.

Banquereau and *Sable Island Banks*, the outer part of the former being about 170 miles S.E. of Cape Canso. *Sable Island* and its banks have been described on pages 843—845.]

The distinctive features of the coast eastward of Halifax are often not to be perceived, in the usual weather, at the distance which the outlying dangers render it prudent for a vessel to be kept from the shore. The lighthouses, however, afford great assistance to a stranger in ascertaining his position when first making the land.

HALIFAX HARBOUR, one of the finest in the world, affords space and depth of water sufficient for any number of the largest ships to lie with safety; and although the dangers off its entrance are such as to render great caution necessary, especially in the fogs which usually accompany all winds from the sea, it is yet easier of access and egress than any other large harbour on the coast, and is rarely impeded by ice. It is 5½ miles wide at its entrance, between *Chebucto Head* to the S.W. and Devil Island to the N.E., and it continues inland 15 miles, in a N.N.W. direction, to the head of *Bedford Basin*. The more prominent and off-lying dangers are well marked by *buoys*.

The *City of Halifax*, the capital of Nova Scotia, containing about 40,000 inhabitants, stands on the declivity of a peninsula on the western side of the harbour, 8 miles above Chebucto Head. The citadel, immediately in the rear of the city, rises to an elevation of 285 ft. above high water, and with its flagstaff forms a leading mark easily recognised from off the entrance of the harbour. On the city front are numerous wharves, some of which will accommodate the largest vessels, and are furnished with every appliance for dispatch in dealing with cargo. Here is the Canadian railway terminus, where the mails are landed during the winter season. All kinds of supplies are abundant, including coal, which is shipped alongside the wharves or from lighters. There is a dry dock, 580 ft. long, 86 ft. wide, with 36 ft. over the sill at high water springs, and vessels of 2,000 tons can be raised on the three slipways. All kinds of repairs, both to ships and their machinery, can be undertaken.

Lights.—Three lighthouses denote the entrance to Halifax Harbour. One on the western side, placed on *Chebucto Head*, shows a *revolving bright* light, 1 minute, the purpose of which is to guide vessels clear of the dangerous *Duncan Reef* and *Bell Rock*, lying southward of Chebucto Head. On the eastern side of the entrance two *fixed bright* lights are shown on *Devil Island*, which, when in one bearing E. ¾ N., lead southward of the dangerous *Thrumcap Shoal*, which shoal is also cleared to the westward by keeping George Island lights (*two fixed bright* lights, vertical, 20 ft. apart) open westward of Maugher Beach light (*fixed bright*). More particulars of the above lights will be found in "Lighthouses of the World," or in the Sailing Directions which accompany the chart of the Coasts of British America, published by the proprietor of this present work.

Fog Signals.—During thick weather the entrance to Halifax Harbour is well denoted by the steam *Whistle* on Chebucto Head, and the *Horn* on Maugher Beach; also by two *Automatic Whistle Buoys*, one of which, painted *black*, lies well outside the entrance to the harbour, in 36 fathoms water, with Sambro Island lighthouse bearing W. ½ N., distant 8½ miles, and Chebucto Head lighthouse N.W. by W., 6¼ miles. Its position is lat. 44° 28′ 25″ N., long. 63° 22′ 10″ W.*

Having passed this outer buoy, when bound into Halifax, a N.W. ½ N. course for 6 miles will lead to the *inner Whistle buoy*, which is painted *red*, and moored in 20 fathoms water, with Chebucto Head bearing S.W., distant 1·9 mile, and Sandwich Point N. ¾ W., 4 miles. After passing about half a cable westward of this buoy, a North course will lead up the harbour, to George Island, between the buoys marking *Neverfail* and *Thrumcap Shoals*, and westward of Maugher Beach lighthouse.

On nearing the whistle buoys in thick or foggy weather, the lead will verify the vessel's position.

Pilots are stationed on *Devil Island*, and several families reside there.

SAMBRO ISLAND LIGHTHOUSE is a white octagonal wooden tower, 60 ft. high, showing a *fixed bright* light, elevated 115 ft., and visible 16 miles. In foggy weather, an *Explosive Signal*, similar to the report of a gun, is made once every 20 minutes. The island is the resort of pilots.

Sambro Ledges form a dangerous collection of rocky shoals between Chebucto Head and Sambro Island. An *Automatic Whistle buoy* is moored in 25 fathoms, near the South end of the outer bank, 7½ miles S.E. by S. ⅛ S. from Pennant Point.

Directions.—The bank off Sambro Island, terminating in a point, and at the depth of 30 fathoms, 5 miles South of the Sambro Ledges, offers considerable assistance to vessels approaching Halifax from the westward in thick fogs, which so frequently prevail. From the eastward the approach is rendered comparatively easy, by the absence of outlying dangers after passing Shut-in Island, and by the soundings deepening out with tolerable regularity to 30 fathoms, at distances varying from 4 to 6 miles from the shore, until within 2 miles of Chebucto and White Heads, where the depth exceeds 30 fathoms, until within one-third of a mile from the shore. Attention to these soundings, combined with the Fog Signals above described, may enable steamers at times to enter the harbour, notwithstanding the fog, but it is seldom prudent for a large sailing vessel to attempt it under such circumstances.

Captain Dunsterville writes thus:—" In approaching the land of Nova Scotia, do not come into less than 50 fathoms, for though there may be a dense fog in the offing, yet near and over the land it is frequently clear, therefore by sounding frequently, you may, even in a fog, approach the coast; and if you suppose yourself near Sambro lighthouse, by firing a gun, a pilot will very soon offer. The lighthouse is remarkable, and may be seen from seaward at 10 or 12 miles off. The land about Halifax is of moderate height, and may be seen at about 18 miles; Citadel Hill, over the town, may probably be seen much farther; this is where the signal is made for all vessels in the offing. The light on Maugher's Beach kept between N. by E. and North, will lead you clear to the westward of the

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* The *Whistle* is sounded by the exit of compressed air from a long tube attached to the buoy. The air is compressed in this tube by the motion of the buoy, so that in a very smooth sea not much dependence is to be placed on it.

Thrumcap, which is a most dangerous shoal. Chebucto Head lighthouse, bearing N.W., clears all the dangers lying to the S.W. It is worthy of observation, that, in approaching the land near Halifax, in thick weather, when it is just perceptible, the colour of the cliffs eastward of the harbour is *red*, and to the westward *white*."

From the WESTWARD *at Night.*—In approaching Halifax Harbour from the westward at night, shape a course to pass not less than 3 miles to the southward of Sambro Island light, steering E.N.E., and in not less than 30 fathoms water, until the light bears North; when, if not more than 6 miles from it, the vessel will have arrived at the southern prolongation of Sambro Bank. Having crossed the bank into deep water, haul up N.N.E., until the light on Maugher Bank opens out East of Chebucto Head, bearing N. ½ E., when steer for it, keeping well outside the black buoy marking Bell Rock, or so as to pass within a mile or less from Chebucto Head, which is quite bold. Having done so, keep the light bearing between North and N. by E., as the vessel runs towards it, and all the dangers will be avoided except Neverfail Shoal, on which there is not less than 4½ fathoms.

Having arrived abreast the Thrumcap, or brought Devil Island lights in line E. ¾ N., the western side of Thrumcap Shoal will be cleared by keeping George Island lights open westward of Maugher Beach light, as before described. Alter course, as may be necessary, to avoid Lighthouse Bank; and as soon as the light on Maugher Beach bears East, steer N. by E. for Ives Point (or N.N.E., if necessary, to avoid the Middle Ground, on which, however, there is not less than 4½ fathoms), until the light bears S. by E.; then a N. by W. course, keeping the light astern, will lead between the Pleasant Shoal and Reed Rock *black* buoys on the one side, and Ives Knoll *red* buoy on the other, into the harbour. Having passed Ives Knoll, the vessel may proceed in on either side of George Island, or may anchor in the stream of Macnab Island until daylight, according to circumstances. The light on Maugher Beach disappears behind Ives Point, as a vessel runs in to the eastward of George Island, which is the wider and preferable channel in a dark night. Within George Island there is nothing in the way, excepting Dockyard Shoal, and the shallow water off Dartmouth.

By Day.—Approaching from the westward in the daytime, pass Sambro Island lighthouse at the distance of 3 or 4 miles, and when Sandwich Point opens out East of Chebucto Head, stand in N. by E. or N.N.E., according to the wind, until the citadel flagstaff opens East of Sandwich Point, bearing N. ¼ W. Keep the citadel flagstaff only just open, running towards it, and it will lead between the Lichfield (marked by a *black* buoy) and Neverfail Shoals, the latter marked by a *spar* buoy South of it, and up to Mars Rock *black* buoy, which leave on the port hand. Having passed Sandwich Point, from which the shallow water does not extend beyond a cable's length, steer towards George Island, keeping Chebucto lighthouse only just in sight East of Sandwich Point, and bearing S. by W., until the vessel has passed close to the westward of the Middle Ground; then open out the head more, so as to leave the Pleasant Shoal and Reed Rock *black* buoys to the westward, in running towards George

Island; or, if it be preferred, the tower of Dartmouth Rink, just open of the eastern side of George Island, bearing North, will lead to the eastward of the Middle Ground. Either of the marks just given will lead clear up to George Island, on either side of which the vessel may pass into the harbour, leaving the Belleisle and Leopard buoys to the westward, if she passes between them and the island, and choosing her anchorage off the wharves of the city, or off the Dockyard.

From the Eastward *at Night.*—Approaching from the eastward by night, and being to the westward of Jedore Ledges, run along the land in a depth not less than 30 fathoms, until the lights on Devil Island are seen; then, if it be intended to pass to the southward of the Rock Head and Portuguese Shoal (the former marked by a *black* and *white striped* buoy, and the latter by a *red* and *black banded* buoy), steer for Chebucto Head until near the Whistle buoy (remembering that to clear the Rock Head, the light on Sambro Island must be kept wide open to the S.E. of White Head, bearing nothing to the southward of S.W. by W.; and the lights on Devil Island nothing to the eastward of N.E. by N.), until the light on Maugher Beach bears North; when steer for it, keeping it bearing between North and N. by E., and proceeding as already directed.

By Day steer for Chebucto Head until the citadel flagstaff is only just open East of Sandwich Point, N. ¼ W.; then steer for the flagstaff, and proceed as before.

Between the Rock Head and Thrumcap.—If a N.E. wind, or other circumstances, should render the passage preferable between the Rock Head and Thrumcap Shoals, proceed as follows:—

By Night.—Having passed Shut-in Island, steer so as to pass not less than half a mile, or more than 1 mile, to the southward of Devil Island. Having passed Devil Island, the high light on the South end of that island, bearing E. by N. and open southward of the low light, will clear Thrumcap Shoals. From a position a mile southward of Devil Island, steer to the westward, until the light on Maugher Beach bears North, when proceed as before directed. A large vessel should not use this channel at night.

From Sambro Island to Cape Sable, the bearing and distance are W. by S. ¼ S., 109 miles. From Halifax, westward, to St. Margaret Bay, the country appears, from the offing, very rocky and broken; the shore is steep-to, and bounded with white rocky cliffs, fronted by numerous off-lying islets and rocks. The high lands of *Aspotogon*, on the western side of St. Margaret Bay, are most remarkable; the summit, very conspicuous, is 483 ft. high, and may be seen at the distance of 20 miles. Proceeding westward from Mahone Bay, the rocks which surround the shore are black, with some banks of red earth. *Cape le Have* is an abrupt cliff, 95 ft. high, bare on the top, with a red bank under it, facing the south-westward. Between this cape and Port Metway there are some hummocks inland, about which the country appears low and level from the sea; and on the shore, white rocks and stony beaches, with several low bare points. Hence to Shelburn Harbour the land is woody. About the entrance of Port Latour, and inland, are several barren spots, which, from the offing, are easily discerned; thence, to Cape Sable, the land appears level and low, and on the shore are some cliffs of exceedingly white sand, particularly in the entrance of Port Latour, and on Cape Sable, where they are very conspicuous from the sea.

CAPE SABLE LIGHTHOUSE.—Cape Sable is the southern cliff of a sandy islet, white, broken, evidently diminishing, and may be seen at the distance of 15 miles. The lighthouse is an octagonal white tower, 50 ft. high, showing a *revolving bright* light, attaining its greatest brilliancy once in every 40 seconds; the light, visible 15 seconds, is elevated 53 ft., and visible 12 miles.

In foggy weather, a steam *Whistle* sounds a blast of 10 seconds in every minute.

From Cape Sable Island rocky ledges extend nearly 3 miles, both to the South and W. by S.; this coast should not be approached without a commanding breeze and clear weather. The tide, both ebb and flood, sets directly across these ledges, the flood westward; the ebb, setting with rapidity to the N.E., causes a strong break to a considerable distance from shore. The tide runs at the rate of 3, and sometimes 4, knots; and when the wind blows fresh, a rippling extends from the breakers southerly to the distance of nearly 10 miles, and shifts its direction with the tide; with the flood it is more westerly, and inclines to the eastward with the ebb. This ripple may be dangerous to pass through in a gale, as it has the appearance of high breakers, although there is not less than 8, 10, 12, and 20 fathoms of water, rocky ground. It is high water at the cape, on full and change, at $9^h 49^m$; springs rise 12¾ ft., neaps 10¼ feet.

Brasil Rock, the outer danger off this coast, is a flat rock, covering an area of about 10 yards, and having 11 ft. over it at low water, in calm weather. Within 100 yards from its base there is 6 to 8 fathoms; to the southward, at about 1 mile from the rock, the depths are from 18 to 20 fathoms; but toward the shore the soundings are regular, 15 to 19 and 20 fathoms. The tide, by running strongly over the shoal ground, causes a great ripple, and makes the rock appear larger than it really is. From it Cape Negro appears N.E. ¼ N., distant 10 miles; Cape Baccaro lighthouse, N. ⅜ E., 5½ miles; and Cape Sable lighthouse, N.W. by W., 7⅜ miles. Its position is lat. 43° 21′ 15″ N., long. 65° 27′ W.

Seal Island Lighthouse.—Seal Island, the outermost of the chain of islands westward of Cape Sable Island, is low, thickly wooded, and surrounded with dangerous shoals. The lighthouse, near its South end, is an octagonal white tower, 60 ft. high, from which Cape Sable lighthouse bears E. by S. ½ S., distant 16¾ miles. The light is *fixed bright*, elevated 98 ft., and visible 16 miles. In foggy weather, a *Whistle* sounds *two* blasts in every minute, each blast lasting 5 seconds, separated by an interval of 5 seconds.

Blonde Rock, the outer danger, lies 3½ miles S. ⅛ E. from the lighthouse on Seal Island, and is uncovered at low water, with 7 to 10 fathoms close around it. Within a mile westward of it there are heavy and dangerous overfalls, which present an alarming aspect.

Off the West side of Seal Island is the rocky islet called the *Devil's Limb*, which may at all times be seen. Between this and Blonde Rock lie *Elbow* and *Zetland Shoals*, breaking in heavy weather.

Bay of Fundy.—The navigation of the Bay of Fundy, complicated by its furious tides and dense fogs, requires extraordinary caution, and we cannot attempt here to explain its nature.

The *Coast of Maine*, also, is so intricate, its inlets so numerous, and fronted by almost innumerable rocks and islets, that a very lengthened description would be necessary to explain its character. The lighthouses on the outlying rocks and islands show the outer limit of this labyrinth, and further description will be found in the Directions accompanying the chart of the Coasts of British America.

BOSTON.—From Cape Sable lighthouse to Boston lighthouse, the bearing and distance are West, southerly, 232 miles, but it should be remembered that the dangerous rock on *Cashe's Ledge* lies only 12 miles to the northward of this course. The lighthouses of Cape Ann, and those on the Cape Cod Peninsula, are the most prominent points in. approaching Boston. From Egg Rock lighthouse, off Nahant Peninsula, to Minot's Ledge lighthouse, on one of the Cohasset Rocks, the bearing and distance are S. by E. ¾ E., 11½ miles. and in this interval are the various entrances to the extensive series of channels and bays which collectively form the harbour of Boston. No verbal description can give an adequate idea of this labyrinth of islands, rocks, and shoals; the chart must be referred to.

The assistance of a pilot is always necessary, and this cannot be too strongly insisted on, for, notwithstanding that the principal dangers are beaconed and buoyed, and the points of approach well lighted, yet it should never be attempted without either an exact knowledge of its intricacies, or the aid of a competent pilot.

Boston Harbour, one of the best in the United States, is spacious and safe, but the entrances are intricate, with a depth of only 22 ft. in some parts at low water, or 32 ft. at high water. It is rarely obstructed by ice. The city, the capital of Massachusetts, stands on a small peninsula 9 miles from the sea, and the largest vessels can lie afloat abreast the quays, in the channel, which is here 400 yards wide. At *Charlestown*, North of the city, is the Navy Yard, with a dry dock 373 ft. long, 50 ft. wide, with 25 feet over the sill. Supplies of all kinds are abundant, and there is every facility for the repair of vessels and their machinery. Being the terminus of several lines of railway, this port is the focus of a considerable commerce. It is high water here, on full and change, at 11^h 27^m; springs rise 11¼ ft., neaps 10 feet.

Boston Lighthouse, the principal lighthouse, is on *Little Brewster Island*, on the North side of the main entrance, in lat. 42° 19′ 39″ N., long. 70° 53′ 25″ W. It is a white tower 80 ft. high, showing a *revolving bright* light every half-minute, elevated 102 ft., and visible 16 miles. At 19 yards to the southward is an auxiliary *fixed* light, showing *bright* over the fairway, between S. 60° W. and S. 69° W., and *red* on either side. In foggy weather, a *Siren* sounds a blast of 5 seconds at alternate intervals of 10 and 40 seconds.

Minot Ledge Lighthouse, 6⅔ miles S.E. ½ E. from Little Brewster Island lighthouse, stands on the outermost of the *Cohasset Rocks*. It is a dark gray granite tower, 89 ft. high, showing a *group-flashing bright* light, thus:—*one flash*, then *eclipse* of 3 seconds, then *four flashes*, an *eclipse* of

3 seconds, followed by *three flashes*, and an *eclipse* of 15 seconds; it is elevated 84 ft., and visible 15 miles. In foggy weather, a *Bell* is struck every half minute.

The Narrows Light, on the West end of the Brewster Spit or Bar, abreast the Narrows, at 1¼ mile W. ½ S. from Boston lighthouse, is a *fixed red* light, exhibited from a screw-pile lighthouse, 45 ft. high, and is visible 8 miles. In foggy weather, a *Bell* is struck every 20 seconds.

Long Island Lighthouse is a brown iron tower, 36 ft. high, on the N.E. end of Long Island, on the South side of President Road. The light is *fixed bright*, elevated 119 ft., and visible 17 miles.

Deer Island Spit Lighthouse, on the opposite side of the channel to Long Island, is a brown iron tower, in 6 ft. water, showing a *fixed bright* light, with a *red flash* every half minute, elevated 53 ft., and visible 13 miles. In foggy weather, a *Bell* is struck once every 10 seconds.

OUTER DANGERS.—The *Graves* are a parcel of dry rocks which appear white, lying 2½ to 3 miles N.E. by N. from Boston light. At half a mile N. by E. of the N.E. ledge is an automatic *Whistle buoy*, in 13 fathoms water, Long Island light bearing W.S.W., distant 5 miles, and Boston light S.W. by S., 3½ miles.

Thieves Ledge, of 4½ fathoms, lies E. by S. ½ S. from Boston light, distant 2½ miles.

Harding Ledge is dry at low water, and on the drying part a *beacon* shaft is raised, having on its summit, which is 31½ ft. above low water, a cast-iron ring, set horizontally, with twelve wooden pendants attached to the rim. This beacon is entirely black, and from it Boston lighthouse bears N.W., 2½ miles; Martin's Ledge, N. ½ W., 2½ miles; and Minot's Ledge lighthouse, S.E. ½ E., 4½ miles. A *bell buoy* lies off the N.E. side of the ledge, and inside this buoy is another *buoy*, in 8 fathoms, carrying a *fixed bright light*.

Martin Ledge, nearly midway between Thieves Ledge and the Graves, has 13 ft. on it at low water. Outside the ledge, in 6 fathoms, there is a *red* buoy. *Tewkesbury Rock*, with 9 ft. over it, lies between this and the Outer Brewster; and at 1¼ mile E. ½ N. from Boston light is *Boston Ledge*, of 15 ft., marked by a *red* buoy.

Directions.—In coming from the vicinity of Cape Cod, you should keep to the northward of the direct course, if the wind is N.E.; and to the westward if it is S.W., making allowance for the tide. With a leading wind, a direct course may be made good on the flood; but the ebb sets toward Minot Ledge. If from the vicinity of Cape Ann, no particular precautions are necessary.

Should you fall in with the Scituate land, in a depth of 10 or 12 fathoms, without having seen the light on the Cohassets, during the night, or thick weather, run North into 17 or 18 fathoms, and steer W.N.W. for Boston light. From the lighthouse on the Cohasset Rocks, Boston lighthouse bears N.W. ½ W., distant 7 miles. *Davis Ledge* lies 4 cables E.S.E. from Cohasset lighthouse, and has a *black* buoy to the N.E. of it. When near the land, and approaching Minot Ledge, bring the point of Scituate to bear South, and steer North, which will clear Davis Ledge, three-quarters of a mile to the eastward; and when the lighthouse on the Cohassets bears

West, steer N.W. ½ W. for Boston lighthouse, which will lead to the N.E. of the bell buoy off Harding's Ledge; but in thick weather it is more prudent to steer N.W. until up with the bell buoy, bearing West, then W.N.W., allowing for wind and tide.

From off Nahant Head, and bound for the Main Ship Channel, bring the light on Egg Rock to bear N. by W. ½ W., and steer S. by E. ½ E. to pass the Graves, passing less than half a mile to the eastward of the Signal buoy marking them; and when it bears N.W., distant at least 1 mile, steer S.S.W. until up with the bearing for entering the channel. Vessels may pass inside the Graves, keeping about 1 cable's length from their S.W. point.

Vessels working to windward in Boston Bay up the harbour, may, in the daytime, stretch safely anywhere between Minot's Ledge and Nahant Head, until up with the Graves on one side and Harding's Ledge on the other. Do not come nearer the N.E. part of the Graves than half a mile, but the Hardings may be approached pretty near to the bell buoy. Inside of the line from the Graves to the Hardings you may stand to the southward to within half a mile of the shore, and to the northward to within three-quarters of a mile of the East end of the Outer Brewster, or the East end of the Shag or Egg Rocks.

When up with Egg Rocks, you must stand no farther to the northward than to bring Boston and Long Island lights in range, and in passing Point Allerton be careful not to go inside the buoy. A vessel, not having a pilot, even if a stranger, may beat up to the anchorage inside the lighthouse, in the daytime, by making short boards, and keeping 2 cables from Lighthouse Island, but should wait there for a pilot.

If working up for Boston Harbour in the night, you will avoid the Cohassets and Harding's Ledge by not standing farther to the southward than to bring Boston light to bear W.N.W.

Main Ship Channel.—When abreast of the lighthouse, bearing North, and in mid-channel, a W. by N. ½ N. course made good leads towards the pile lighthouse on the spit; but if the tide is ebb, or you are on the North side of the channel, steer West or West, southerly, so as to avoid getting on the False Spit. Leave the lighthouse on the starboard hand, and steer N.W. ¼ W. past George Island. In this course you will have Nix's Mate Beacon and the middle of Bunker Hill Monument in range, until up with the eastern end of Gallop Island. From this point the course through the Narrows is N.W. by N., keeping in mid-channel, and steering for the high land on Deer Island, until up with the buoys off Nix's Mate, which leave on the port hand.

When you are passing Nix's Mate, you should have Deer Island Spit lighthouse on with the N.E. end of Apple Island, for a light ship, and off the South part of Apple Island for a vessel of heavy draught. By observing either of these marks, you will avoid the shoal ground about Nix's Mate. A W. ¾ N. course leads from Nix's Mate through President Roads, until the beacon on the high part of Long Island is just clear of the N.E. bank of Spectacle Island, when the course is N.W. ¾ N., keeping the marks astern in range until abreast of the beacon on the S.E. part of Bird Island.

In steering this latter range, it will lead safely past the Lower Middle, Castle Island Rocks, Governor Island Point, the Upper Middle, and in the best water over the shoal ground above the Upper Middle. When up with the beacon on Bird Island, steer N.W. by W. ¾ W. towards the State House, until abreast of the buoy on Slate Ledge, and then N.W. by N. ½ N. for the anchorage.

Hypocrite Channel passes between the Outer Brewster on the South, and the Sunken Rocks to the northward, thence between Green and Little Calf Islands to Ram Head, where it joins the Broad Sound Channel. This channel is only fit for those acquainted with it, and therefore not to be attempted without a pilot.

Black Rock Channel leads from the Main Ship Channel at the pile lighthouse into Hypocrite Channel, and is never used by large vessels except in the winter time, to avoid the ice in the Narrows. This channel, too, is narrow and dangerous, and not fit for strangers to attempt.

Broad Sound Channels.—Vessels intending to enter by the *South Channel* may stand in anywhere between Nahant Head and the Graves, and steering to the South of West, until they bring Nix's Mate beacon to bear S.W. by W. ¼ W., may run for it. The beacon then appears in the middle of the northern and highest of the Blue Hills. This channel is short and straight; its range is perfect, and is safe at half or three-quarters flood for the largest ships, especially for vessels outward bound. Vessels going out this way will leave Ram Head, Aldridge Ledge, and Devil's Back buoys on the starboard hand, and the Little Faun and Great Faun buoys on the port hand; and in running out of Broad Sound will keep Egg Rock open of Nahant Head.

The *North Channel* passes nearer Deer Island, and is separated from the South Channel by a middle ground. The buoys are passed in the same way as in the latter. The range for this channel is the North head of Long Island (on which the lighthouse stands), in line with the second bluff on the West side. This channel cannot be recommended, and should not be attempted in bad weather, even by small vessels.

There is another channel out, used by vessels in light winds on the ebb, to prevent being set into the Sound at Nix's Mate, or the East end of Lovell Island. This is to the southward of President Roads, Spectacle Island, and Long Island, and through Nantasket Roads to the Main Ship Channel South of Boston light, and is termed the *Back* or *Western Way.*

Vessels waiting for a pilot may anchor in the Main Ship Channel anywhere between the lighthouse and Nantasket Beach.

Vessels from Boston Bay, bearing away for Cape Cod Harbour, must endeavour to fall in with Race Point lighthouse, and run for it until within half a mile; when it bears E.N.E., haul up E.S.E., or as near as the wind will permit, and anchor in from 10 to 4 fathoms, in Herring Cove, where there is good shelter with the wind from N.N.E. to S.E. by E. Should the wind shift to the N.W., Provincetown Harbour is under the lee. Should you first make Cape Cod light, bring it to bear E. by N., and run for it until you have soundings in 14 or 15 fathoms; then steer N.E. until the light bears E. by S.; then run in N.W. for the harbour.

It is high water, on full and change, off Race Point, at 10^h 45^m. Vessels leaving Cape Cod, bound to Boston, should calculate the tide, as the flood sets strongly to the S.W. off Cape Cod, from the Race to Chatham; the flood sets to the South, the ebb to the North; southern tide 9 hours, northern tide 3 hours.

Stellwagen Bank is an extensive bank of 10 to 18 fathoms, fronting Massachusetts Bay, and situated almost immediately in front of the harbour of Boston. It commences at about 6½ miles N.N.W. from the lighthouse on Race Point, where is a small shoal spot of 10 fathoms; thence it extends in a curved form, the curve being to the eastward, 18 miles in a northerly direction to its North end (19 fathoms), which is situated 16 miles S. by E. ½ E. from Thatcher's Island, Cape Ann. The soundings close to its edge are 30 to 20 fathoms, deepening rapidly eastward and westward, the 100-fathoms line being at little more than 10 miles from its eastern side. Between its northern end and Cape Ann the depth is 40 to 55 fathoms. It forms an extremely valuable guide to vessels making Boston in thick weather, as a single cast of the lead upon it (the soundings eastward of it being so deep) is sufficient to determine a vessel's position with some degree of certainty. It has been buoyed, a *red* buoy having been placed on the 10-fathoms patch at its South end, a *black* and *white* one in the middle, and a *black* one at its North end.

Cape Cod Highlands Lighthouse is a white tower 55 ft. high, showing a *fixed bright* light, elevated 183 ft., and visible 20 miles. In foggy weather, a *Trumpet* sounds a blast of 8 seconds at intervals of 30 seconds.

NANTUCKET SHOALS.—These very dangerous shoals, the "Goodwin Sands" of the United States, lie immediately in the line of traffic of the coasting trade. They reach for 38 miles S.E. of Nantucket Island, with depths varying from 4 ft. to 10 fathoms over them, and are liable to great alterations both in form and position. It must also be remembered that many of these shoals are so far from land that no marks can be given, beyond that afforded by the lightship on their South extremity. Unless in case of necessity, no vessel should become entangled in this labyrinth, for the currents and tides are here most devious, the weather thick at times, and the more prominent shoals shown by tremendous breakers, while others are only to be distinguished by ripplings, more or less strong, according to the tide or current, or by a discoloration of the water.

Davis New South Shoal, the south-westernmost of the Nantucket Shoals, has 8 ft. least water over it, at 19½ miles South of Sankaty Head lighthouse. No part of Nantucket Island is visible from the shoal; but the light on Sankaty Head is distinctly visible when the weather is clear, and is a valuable mark to indicate its position.

The Lightvessel, moored in 17 fathoms, about 12 miles S.W. by S. ½ S. from the 8-ft. patch, is painted red, and has a funnel and two masts, with a cage and light on each mast. Two *fixed bright* lights are shown, each elevated 38 ft., and visible 11 miles. In foggy weather, a steam *Whistle* gives two blasts in every minute, as follows —a blast of 2 seconds, silent 28 seconds, then a blast of 6 seconds, and silent 24 seconds.

Sankaty Head Lighthouse, 65 ft. high, is painted white with a red band, and shows a *fixed* and *flashing bright* light, with a flash of 10 seconds every minute, elevated 166 ft., and visible 19 miles. This, and the lightvessel, form the only guides for vessels in the vicinity of these dangers.

Old South Shoal has from 6 to 18 ft. water on it, and is 2½ miles in extent; from its shoalest part, Sankaty lighthouse bears N. ¾ W., distant 13 miles, and the 8-ft. patch of New South Shoal S. by W., 6¾ miles.

Within the Old South Shoal there are many dangerous shoals, as shown on the chart, the northernmost patches, known as *McBlair Shoals*, having depths of 9 to 18 ft. over them. From the outer patch of 18 ft., Sankaty lighthouse bears S.W. ¾ W., distant 13 miles, and at 2 miles N.W. of it is a *red bell* buoy. They are sharp, abrupt ridges of fine white sand, which are readily discovered by the rip of the tides at all times, except at slack water, and by daylight they exhibit the usual discoloration.

To the southward of McBlair Shoals, a line of breakers and shoal patches, called the *Great Rip*, extends to lat. 41° 9′; to the East of the southernmost of these patches, with 9 ft. water, a *buoy-boat* is moored. To the East of this is another long shoal, *Davis Bank*, on which there is only 2, 3¾, 4, and 5 fathoms, over an extent of nearly 20 miles. From the N.E. end of Davis Bank, shoal patches of 2¾ to 10 fathoms extend 10 miles to the south-eastward, and join the East end of the shoal known as the *Fishing Rip*, a line of shoal patches, with 4 to 9 fathoms on it, between 40° 58′ and 41° 8′. Southward of this are some 10-fathoms patches. *Phelps Shoal*, the outermost of the Nantucket Shoals, has a least depth of 10 fathoms on its S.W. end, at 39½ miles S.E. by S. ¼ S. from Sankaty lighthouse.

Tides.—The main body of the flood tide runs to the eastward, the ebb to the westward. The currents always run across the line of directions of the shoals, and are much more rapid during their passage. This makes a near approach particularly dangerous on the side toward which the tidal current is setting. The current is never still; during what is called slack water, the velocity is rarely less than one-half, sometimes more than 1 mile. A careful attention to currents is important in this vicinity. It is high water, on full and change, at $12^h 4^m$; the mean rise and fall, 3 feet 2 inches.

From the South Shoal lightvessel to Montauk Point lighthouse, at the East end of Long Island, the bearing and distance are W.N.W., 88½ miles. From Montauk Point the South coast of *Long Island* trends W. by S. ½ S., for 33 miles, to *Shinnecock Bay*, in the rear of which is a red lighthouse, 150 ft. high, showing a *fixed bright light*, visible 19 miles. From hence to *Fire Island Inlet*, at which there is another lighthouse, 152 ft. high, with a *revolving bright light*, 1 minute, the bearing is W. by S. ¼ S., 35 miles, and from hence to Sandy Hook it is W. ½ S., 37 miles.

NEW YORK HARBOUR is very commodious and landlocked, but the approaches are barred by extensive shoals, through which there are several channels. *Gedney's Channel*, the principal entrance, passes close round Sandy Hook. Vessels drawing 24 ft. can enter at low water, and at high water the depth in the channel is about 30 feet. At the city there is every accommodation for the largest vessels, including floating and dry docks, with every facility for repairs.

We cannot here attempt to enter into a full description of this great port, but must leave that to the Chart and Sailing Directions for the East Coast of the United States, published by the proprietor of this work. All that is necessary here is to give some remarks on the approaches from sea. All vessels entering are bound to take a pilot, and their boats are always to be found between Nantucket and Cape May. A stranger is strongly recommended to accept their services at once.

Sandy Hook Lightvessel lies in 12 fathoms, off the entrance to New York Harbour, nearly 8 miles E. ¼ S. from Sandy Hook principal lighthouse. She is painted red, with two masts, having a framework disc on each, and shows on one mast a *revolving red* light, attaining its greatest brilliancy once every half-minute, and on the other a *fixed red* light, both elevated 37 ft., and visible 11 miles. In foggy weather, a steam *Whistle* gives a blast of 3 seconds at alternate intervals of 1 and 30 seconds.

Scotland Lightvessel, 3¼ miles W. ¾ S. from Sandy Hook lightvessel, shows two *fixed bright* lights, visible 12 miles, and a *Bell* is sounded in foggy weather.

Sandy Hook Main Lighthouse is a white tower, 77 ft. high, showing a *fixed bright* light, elevated 90 ft., and visible 15 miles.

The HIGHLANDS of NAVESINK LIGHTHOUSES are two brown towers, each 50 ft. high, and 76 yards apart N. by W. ¾ W. and S. by E. ¾ E., the northern one being situated 4 miles S. ¼ E. from Sandy Hook lighthouse, and in lat. 40° 23′ 45″ N., long. 73° 59′ 11″ W. They each show a *fixed bright* light, elevated 248 ft., and visible 22 miles.

These lights, with those at Montauk Point, Shinnecock, and Fire Island Inlet, mark the approaches to the entrance of New York Harbour by night, and we now proceed to give some observations for the guidance of vessels approaching by day, referring the reader to the Sailing Directions already mentioned for full and complete instructions.

Directions.—The Gulf Stream, by its high temperature, gives the first warning, in approaching the American coast from the eastward. In lat. 38½° N. it is nearly 360 miles from the land, measuring on a parallel of latitude, and immediately after passing through it the temperature will be observed to fall. There is also a fall of temperature on striking soundings, which will indicate the time when the deep-sea lead ought to be used. With the decrease of soundings the colour of the water will change; from dark blue in a depth of 150 fathoms the colour alters to light blue in 50 fathoms, and becomes of a greenish tint as the coast is approached.

When nearing the land, the chart of the approaches is the best guide, both for the depth and quality of bottom, and Lieutenant Murray founded an elaborate description on its indications which cannot be quoted in full here.

The general soundings, up to the 20-fathoms line, follow the general form of the shore, and between 80 and 100 fathoms the water suddenly deepens. The 20-fathoms line is 31 miles from Cape May, in an E. by S. direction, but less than 7 miles from Montauk Point. A depth of 20 fathoms off the East point of Long Island is therefore too near the land, unless with a commanding wind; while 20 fathoms off Cape May is a safe distance from the shore.

The latitude of a ship's place is usually better known than the longitude, but the latter is most important on approaching this coast, and can be determined approximately from the latitude, in connection with the distance, lines of depth, and quality of bottom.

East of the entrance of the Delaware, the bottom in 100 fathoms is mostly dark gray sand mixed with broken shells. To the North of this parallel it is mostly green and blue mud mixed with sand. Eastward of Delaware Bay, between 100 and 40 fathoms, the bottom is most frequently sand and broken shells; inside of 40 fathoms, gray or yellow sand with black specks. North of this parallel the bottom is as often mud as sand, the mud being more frequent going to the N.E. until off Block Island, where the bottom from 100 to 20 fathoms is mostly green mud or oaze, known as the Block Island Soundings. Green mud or oaze cannot be found within 15 miles of Block Island, and seldom to the West of the meridian of Montauk Point in less than 30 fathoms water.

Between 40 and 20 fathoms, off the coast of Long Island and New Jersey, the character of the bottom changes so often between these depths, that constant reference must be made to the chart.

In general, the soundings decrease regularly and more or less gradually from 100 or 80 fathoms to the shore, but there are some remarkable exceptions, among which may be mentioned the Five Fathoms and other banks at the entrance to the Delaware. The principal exceptions are, however, the *Mud Holes*, which extend in a S.E. direction from Sandy Hook, and form a very remarkable gorge. When passing over them, the least distance from Navesink lights, at which a depth of 100 fathoms is found, is 80 miles.

These Mud Holes form a very singular feature, which may mislead if not known. Before the approaches to New York Bay were closely examined, they were considered to be a series of deep detached holes, extending in a line S.E. of Sandy Hook. The careful survey completed in 1885 shows, however, that a narrow gorge or submarine channel indents the bank of soundings, having a width of 1 to 2 miles, and forming a slight curve S.W. of a line from Navesink lights to lat. 39° 30′ N., long. 72° 10′ W., which geologists consider may be the ancient channel of the Hudson River. It commences 8 miles E. by S. from Navesink lights, where the depth is 19 fathoms, and in the next 15 miles, in a southerly direction, increases in depth to 36 fathoms, with 16 to 18 fathoms, sandy clay, on either side. At about 18 miles farther on, it has increased to 40 fathoms, with 20 to 27 fathoms on either side; thence it continues for about 43 miles, with depths between 40 and 43 fathoms, and 30 to 39 fathoms around.

In about lat. 39° 40′ N., long. 72° 31′ W., the depth suddenly increases from 50 to 183 fathoms, and in the next 20 miles to the S.E., irregular soundings to over 450 fathoms are found, with a knoll of 64 fathoms, mud, gravel, and shells, near the centre, and 50 to 100 fathoms on either side of this "ravine" or "hole." This is separated from the deep ocean by a ridge, on which 129 fathoms was the least depth found.

In case of need, such as when the reckoning is lost in foggy weather, this gorge will, by careful attention, form a good guide.

It has been observed that in approaching Sandy Hook, the soundings to the southward are full of black specks, between the depths of 10 and 20 fathoms; in the true channel they are of mud; while to the northward, near Long Island, they are of black and white sand.

In Foggy Weather, &c., the instructions deduced from the foregoing observations will doubtless be of considerable service. Therefore, when coming from the eastward, and striking soundings in more than 35 fathoms, green mud, steer to the northward of West, shoaling the water very gradually on that course. If beating against a westerly wind, do not stand into less than 18 fathoms on the northerly tack, till nearly up with Fire Island lighthouse, for the soundings inside 25 fathoms decrease very rapidly towards the Long Island shore, but very slowly towards that of New Jersey, a distinction that should be carefully borne in mind.

When coming from the southward, a depth of 15 fathoms and upwards should be preserved, for to the northward of Barnegat Inlet 10 or 12 fathoms is found within 1¼ mile of the beach. When the water has decreased to 15 fathoms, the lead should be kept constantly going and the bottom examined; gravelly bottom indicates too near an approach to the land.

On approaching the land, the appearance of Long Island is generally low and level, excepting a few hills, which lie 40 miles to the westward of Montauk Point. Along the South side of the island a flat extends all along the shore, which at the mouths of some of the inlets, especially those westward of Fire Island, runs off about a mile. Your course from 10 miles off Montauk Point towards Sandy Hook is W. by S. ½ S., 55 miles, and then W. ½ N., 45 miles. At 12 miles southward of Montauk Point there is 26 and 23 fathoms, coarse gray sand and gravel, with black specks, which depth is maintained at the same distance from the land until you get to about 20 miles eastward of Fire Island lighthouse, when you will meet with soundings of 20 to 18 fathoms, thence decreasing to 16, 15, 14, and 13 fathoms, and again deepening to 16 fathoms as you approach the harbour of New York. Within this distance from the shore, it is not safe for a large ship to approach without a commanding breeze, because the coast of Long Island is steep-to, having 6 and 7 fathoms close off the edge of the flat, and the 20-fathoms line approaches Montauk Point to within 7 miles, the soundings between decreasing very rapidly. In the vicinity of Fire Island Inlet, the depth is shoaler, there being 12 to 15 fathoms at 8 miles from the shore. Outside the depth of 20 and thence to 40 fathoms, the character of the bottom changes so rapidly that constant reference must be made to the chart, as no general description would be at all applicable. The difference in latitude between Montauk Point and Sandy Hook is only about 37 miles, but there will be no difficulty in determining which of the two you are approaching, as the character of the lights, and that of the soundings, afford an infallible distinction.

In passing South of the Nantucket Shoals, between latitude 39° and 39° 29′, you should take notice, if possible, when you have crossed the Gulf Stream; as, at the distance of 30 miles within it, you may expect soundings; so soon as you obtain which, you will possibly experience a S.W. current.

Should you now be running for the New Jersey coast, to the northward of Great and Little Egg Harbours, you may suddenly strike one of the Mud Holes previously mentioned. In that case, it will be necessary to take particular notice of your position, because many shipmasters have been deceived, especially by those near Sandy Hook, and fancying themselves at a greater distance from the coast of New Jersey than they really were, have run on and put themselves to considerable inconvenience, and even danger. It should be remembered that the coast of New Jersey is steep-to, there being 6 to 10 fathoms immediately off it.

In beating to windward of Sandy Hook, in from 12 to 15 fathoms, when waiting for a pilot or a wind, either by day or night, when the lighthouse bears nearly West, you will be sufficiently near to Long Island.

Should you fall in so far to the southward as to approach *Cape Hatteras*, be very cautious of its shoals, and bear away to the N.N.E., so as to obtain soundings on the Jersey shore. When you have gained 28 or 26 fathoms in latitude 40°, haul in to make the land.

It has been remarked that ships from sea, approaching any part of the American coast between Long Island and Cape Hatteras, if in doubt about their reckoning, should take notice of the Gulf Weed, which is more plentiful, and in larger clusters, to the eastward of the Gulf Stream than in it, where the sprigs are but small and few. Inside the Stream there is no weed, unless in rare instances, and there, as before observed, the colour of the water changes to a still darker and muddy colour.

If you fall in to the *northward* of the *Chesapeake*, approach Chincoteague and Winter Quarter Shoals, marked by a light-vessel, no nearer than into 15 fathoms; from this steer N. by E. until nearly up with Great Egg Harbour, keeping the lead going. You may advance towards this place, and to the northward, to the depth of 15 fathoms. From Great Egg Harbour to lat. 39° 30′ the shore trends about N.E. by N., thence to the Highlands of Navesink nearly N. by E.

Should you fall in so as to make the *Capes of the Delaware*, keep above 18 miles off the land, or in not less than 15 fathoms, to avoid Five Fathoms Bank, which is marked by two lightvessels. After passing the bank, which is steep-to, you may haul up N.E. for 45 miles, which will lead into 15 fathoms, off Little Egg Harbour, and by altering the course to N.N.E. for 18 miles, you will reach Barnegat. Here the soundings will be coarse gray sand, with a few shells and gravel; and having these soundings, you may steer along in the direction of the land N. by E., on which course you will have from 16 to 18 fathoms. In the day-time you will notice the *Woodlands*, between Barnegat and Sandy Hook, a remarkable part of the coast, resembling, it is said, no other land between Cape May and the Highlands of Navesink. It is on this part of the coast of New Jersey, between Barnegat and Shrewsbury Inlets, that so many fatal shipwrecks occur from approaching too near the land.

When hauling in for the Woodlands, with the wind off shore, you may, in a small ship, and exercising great care, keep within a short distance of the coast, until up with the Highlands.

On the southern side of the entrance to New York Harbour are the *Highlands of Navesink*, the highest part of which, *Mount Mitchell*, is estimated to be 282 ft. above the sea. This high land is a very important mark when approaching the coast, as it can be seen from the Outer Thirty-seven Fathoms Hole, when 24 miles off, and in a depth of 30 to 37 fathoms water. It appears at first like an island, being pretty level on the summit, except some irregular risings towards Point Comfort, on the West or inland side. As you approach nearer to the harbour, you will see some other high land, situated more at the back of the bay, the first of which may be Hempstead Hill in Long Island, the summit of which is about 320 ft. above sea level. On Staten Island is Tomkins Hill, which is estimated to be 307 ft. high. Both these hills will be seen after you have made Navesink.

As a number of vessels bound into New York have been lost, from heaving-to with their head on shore, we cannot too strongly urge on the shipmaster the necessity, *if he is in doubt of his position, of heaving-to with the head off shore.*

Directions for proceeding onwards into New York Bay must be left for the more extended works previously mentioned on page 867, and to the assistance of the pilots.

Sandy Hook to the Delaware.—To the valley at the foot of the Highlands of Navesink succeeds a low tract of table land, and southward of this is the considerable and remarkable tract of *Woodlands*, which terminates at 18 miles S. by W. from the Navesink lighthouses; next follows an extensive lagoon, named Barnegat Sound, which is fronted by a narrow strip of low land. The coast, from the Highlands of Navesink to the North end of an island called *Barnegat Long Beach*, trends S. by W. ¾ W., 37½ miles, and the soundings decrease regularly towards the shore, from 12 to 7 and 5 fathoms.

In the parallel of 39° 47′ N. is *Barnegat Inlet*, or the entrance of Barnegat Sound, on the South side of which is a lighthouse, 150 ft. high, the upper half red and the lower half white, with a *flashing bright* light, every 10 seconds, visible 19 miles. A shoal bar extends outwards from this place to the distance of 2 miles, and the bottom is an admixture of mud, shells, and gravel. The outer edge of the shoal is steep-to, and you may pass it in 6 fathoms within a short distance from the outer breaker; but, at night, keep in at least 9 or 10 fathoms. The soundings more to the northward in these depths are fine white sand, with very hard bottom.

Barnegat may be readily known in the day, even when the breakers are not seen, as inland there is a long grove of trees, apparently 3 or 4 miles long, directly within the inlet, and commonly called the *Little Swamp.* With the North end of this land directly abreast, you will be to the northward of Barnegat.

Between the North end of Barnegat Long Beach and Cape May, at the mouth of the Delaware, the coast forms a gentle curve, but its general trend is nearly S.W. ¼ S., and the distance 64 miles. The land is generally low and broken, forming innumerable islets and inlets. The soundings are regular, commonly 8 to 10 fathoms at 6 miles from shore; but there is a sand bar at every inlet, several of which extend off to a considerable distance.

Little Egg Harbour, in the parallel of 39° 30′, is a small harbour formed by low islets or beaches on the East, and by salt marshes on the West. It is known as the port of *Tuckerton*. To a stranger this harbour cannot be recommended, unless as a retreat in case of emergency, several shoals about the entrance being dangerous; yet it has frequently served as a place of shelter in the winter, when violent N.W. winds have prevented vessels from entering the Delaware or New York Harbour. The lighthouse, a black tower 46 ft. high, stands on the South side of the Old Inlet, and shows a *fixed* and *flashing* light. A *Whistle buoy* is moored in 8 fathoms, about midway between New Inlet and Absecum Inlet.

Absecum Inlet, 10¼ miles S.W. ¼ S. from Little Egg Harbour lighthouse, is another harbour which affords shelter to vessels of light draught. A lofty tower, 159 ft. high, painted in red and white bands, stands on the South side, and shows a *fixed bright* light, visible 19 miles.

The shoal water extends at least 2 miles off shore at Absecum Inlet, and at 2¼ miles E.S.E. of the lighthouse is a 3-fathoms shoal. *Round Shoal*, with 11 ft. water, lies 1¾ mile S.E. ¼ E. from the lighthouse.

In sailing between New York and the Capes of the Delaware, if the wind should be in the N.W. quarter, with which, in general, there is clear weather, keep no farther off than to 10 fathoms; the nearer inshore the stronger the current, which sets about 1 mile an hour. The flood runs W. by S., and the ebb E. by N., but you will have no tide till farther off than in 8 or 9 fathoms.

If you are turning, with the wind to the westward, stand off no farther than to 18 or 20 fathoms of water. You may venture to stand inshore into 6 fathoms, until you advance towards *Hereford Creek*, or about 6 miles to the northward of Cape May.

The soundings opposite to the entrance of the Delaware are very uneven. At 45 miles eastward from Cape Henlopen there is from 25 to 30 fathoms, decreasing at half that distance to 15 and 16 fathoms. In the channel, near Cape Henlopen, there is from 14 to 16 fathoms; but at 15 miles East from the cape there is only 9 and 10 fathoms.

The greatest danger hereabout is the shoal called the *Five Fathoms* or *Cape May Bank*, lying 14 miles E. ½ N. to S.E. by E. ½ E. from Cape May. Much of the danger is averted by the *two lightvessels*, moored eastward of the North and South extremities.

DELAWARE BAY.—Cape May and Cape Henlopen, the two outer points of the estuary called the *Delaware River*, bear from each other S.W. ½ S. and N.E. ½ N., 10 miles apart, and each is distinguished by a lighthouse. A great tract of overfalls and broken ground extends 6 miles southward of Cape May, with depths from 5 to 15 ft. over them. These shoals form the two channels into the river, of which the chief, between the shoals and Cape Henlopen, is about 4 miles in width, with deep water, but the aid of a pilot is indispensable.

Cape May Lighthouse, on the extreme S.W. point of the cape, is a gray tower, 159 ft. high, showing a *revolving bright* light, 1 minute, elevated 167 ft., and visible 19 miles.

Cape Henlopen Lighthouse is a white tower 82 ft. high, showing a *fixed bright* light seaward, elevated 128 ft., and visible 17 miles.

It is high water at Cape Henlopen, on full and change, at 8^h; springs rise 4½ ft., neaps 3 feet. When the moon Souths, the *ebb* current at the entrance to Delaware Bay, and the *flood* current at Philadelphia, are at their strength. At Newcastle Bight, the strength of the flood occurs 3 hours before the moon Souths, and that of the ebb 3 hours after.

The estuary of the Delaware, for 70 miles from the sea, had no safe natural harbour, and to remedy this defect the Government constructed a *breakwater* within Cape Henlopen, forming a safe harbour. A light is shown on each end of the breakwater, and that on the West end, in line with Lewes light, W. ½ S., leads into the bay, but this line passes close southward of the dangerous *McCries Shoal,* which lies 7 miles S.E. ¾ S. from Cape May lighthouse.

It is unnecessary to enter farther into a description of Delaware Bay and its navigation, which is fully described in the Sailing Directions accompanying the chart. Steam-tugs and pilots usually cruise far outside the Capes. There is no difficulty, with common attention, in running into the anchorage to the South of the breakwater, even in a gale of wind.

Philadelphia is a fine and populous city, about 85 miles up the Delaware, and the river here forms an excellent harbour, which can be reached by the largest vessels. Grain and petroleum figure largely in the exports. There are numerous wharves, with every facility for dealing expeditiously with cargo. Repairs also can be effected to vessels and their machinery, and supplies of all kinds are abundant.

From mid-channel off Cape Henlopen, a course S.E. by S. ½ S., 23 miles, will clear the Cape, and lead well to the eastward of Fenwick Shoal, and when you get the lightvessel, riding off that shoal, to bear about W.S.W., you may alter your course to S.S.W. This course for about 30 miles will bring you nearly abreast of Winter Quarter Shoal, about the parallel of 38°; then a long course of 63 miles S.W. by S., if your vessel will lie well up, will bring you abreast of Smith Island Shoal, with the lightvessel and Smith Island lighthouse bearing W. by N. ½ N.; from hence a W.S.W. course, for 21 miles, will take you to Cape Henry, at the entrance to Chesapeake Bay.

The *Coast of Delaware,* South of Cape Henlopen, is nearly a straight line running due South for 11 miles, to *Indian River Inlet,* and 10 miles farther to the boundary between Delaware and Maryland. It is very low, broken into long narrow islands, with off-lying shoals to the distance of 1 to 1½ mile. In proceeding along these coasts during easterly winds, great caution is requisite; as with such winds the weather is generally hazy, and the coast obscured. The current will generally be found setting to the S.S.W., in the direction of the shore.

Fenwick Island Lighthouse, which stands on the state boundary, is a white tower 82 ft. high, showing a *fixed* and *flashing bright* light, visible 15 miles.

South of the parallel of 38° the shores are formed by numerous islets, swamps, and inlets, and so it continues to Cape Charles, at the mouth of the Chesapeake. In all this extent, the only distinguishing marks useful to a stranger are the lighthouses of Assateague, Hog Island, and Smith

Island. *Matomkin* and *Machi-Pongo* are very dangerous harbours in a gale of wind; but you may ride along shore with the wind from N.W. to S.W. When the wind blows hard at N.E. or E.N.E., and you are in sight of Chincoteague Shoals, your only chance for safety is to stand to the southward, for you cannot clear the land to the northward.

Fenwick Island Shoal, in lat. 38° 27′ 30″ N., long. 74° 55′ 30″ W., is about 2 miles long, N.E. and S.W., with 15 ft. least water on it. It bears S.E. by S., distant 11 miles, from Indian River Inlet, and E. ¼ N., 6 miles, from Fenwick Island lighthouse. On the seaward side the soundings decrease suddenly from 10 to 2½ fathoms, and there is 10 fathoms about 2 miles West of this shoal, which appears to be extending on the West side and towards the North. A lightvessel, showing *two fixed red* lights, lies S.E. of it, and its N.W. side is marked by a *Whistle buoy*.

Isle of Wight Shoal, with only 3 fathoms water, lies 4 miles S. ¼ E. from Fenwick Island Shoal, and 7 miles off the beach. There is 10 fathoms water within a mile on either side of it, and nearly midway between these two shoals there is a spot with 3½ fathoms water on it.

At 29 miles S. ½ W. from Fenwick Island lighthouse is Winter Quarter Shoal, and between them are the *Gull Banks*, 2 to 4½ miles off the beach. At 10 miles South of the latter, and 8 miles off shore, is a small patch of 21 feet.

Winter Quarter Shoal is 1 mile long, E. by N. ¾ N. and W. by S. ¾ S., and one-third of a mile wide, with not over 3½ fathoms water upon it, and 12 ft. in several places at low tide. On the seaward side the soundings change suddenly from 9 to 4, and then to 2 fathoms. It is 6¼ miles distant from the nearest land, with 10 fathoms water between it and the shore. In clear weather the lantern of Assateague lighthouse is just visible from it, and bears W. by S. ¼ S., distant 11½ miles.

At 3 miles E. by S. from it is a patch of 3 fathoms, and near this is the *lightvessel*, showing a *fixed red* light.

Assateague Lighthouse is a red tower 129 ft. high, showing a *fixed bright* light, elevated 150 ft., and visible 18 miles. It is fronted by shoals, and irregular soundings.

Black Fish Banks form a long narrow ridge, 5 miles long, N.E. ½ E. and S.W. ½ W., from 4½ to 6 miles off shore, with from 3¼ to 5 fathoms water upon it. The North end bears E. by S. ¼ S., distant 7¼ miles, and its South end S.E. by S., distant 5¾ miles, from Assateague lighthouse.

Chincoteague Shoals are the outer shoals off Assateague lighthouse, and bearing from it from S. ½ W. to S.E. by E. ¾ E., comprising six points of the compass, and at distances from it of 3¾ to 4¼ miles. They have from 9 to 17 ft. water upon them. A *Whistle buoy* is placed outside them.

In the immediate neighbourhood of these shoals, and especially within 12 miles of Assateague lighthouse, the bottom is exceedingly broken and uneven. The general set of the current along this part of the coast is to the southward and westward; and vessels from the southward have sometimes been set inshore among these dangers by it; so that this part of the coast should be avoided by large vessels, unless well acquainted with the district. Should the mariner suspect himself approaching the land in this vicinity, he should keep the lead going, and after striking soundings in 11 or 12 fathoms should keep a good look-out. In day time large vessels should not approach the land nearer than 10 miles, with the trees just in sight from the deck; and at night, even in clear weather, when coming from the southward, no nearer than to get the light just in sight, and the lightvessel will then be the guide.

Nearly in the latitude of Cape Charles, 4 and 5 miles off the land, are the *Smith Island* and *Shark Shoals*. The former lies 7 miles E. by S. ½ S. from Smith Island lighthouse, and has 3¼ fathoms upon it. The latter lies a little under 5 miles S.E. by E. from the same, and has but 2¾ fathoms upon it. These shoals are small in extent, but the surrounding depths are but moderately greater, and towards the sea deepen gradually, so that at 11 miles from the land you will only find about 10 fathoms. *Cape Charles Lightvessel* is placed in 8 fathoms, eastward of Smith Island Shoal, and shows *two fixed bright* lights, visible 12 miles.

The CHESAPEAKE, one of the finest estuaries on the globe, being over 160 miles in extent to its northern extremity, is the recipient of many important rivers, which fall into it on all sides, but especially on the North and West. At its head is the *Susquehanna*, which runs through Pennsylvania; on the N.W. the *Patapsco*, falling from Baltimore; at 50 miles farther South is the *Patuxent;* then the *Potomac*, which passes the City of Washington; the *Rappahanock*, running downward from Fredericksburg; *York River*, on which are situated York Town and Gloucester; *James River*, on which stands the City of Richmond; and, in the South, *Elizabeth River*, with the harbours of Norfolk, &c.

Its entrance lies between Cape Charles on the North and Cape Henry on the South, being about 10 miles in width, but owing, as it appears, to the southward drift, the northern side of the entrance, like the Delaware, is embarrassed by shoals.

Cape Charles Lighthouse, which stands on *Smith Island*, or above 4 miles eastward of Cape Charles itself, is a white tower 150 ft. high, and shows a dim *fixed* light, varied by a *bright flash* every 45 seconds, visible 19 miles.

Cape Henry Lighthouse is an octagonal tower, 152 ft. high, painted black and white, and shows a *fixed* light, visible 19 miles. The light is *bright*, with a *red* sector between N.N.W. and N.E. by E., over the shoals. In foggy weather, a *Siren* sounds a blast of 5 seconds at intervals of 90 seconds.

As vessels entering the Chesapeake must secure the aid of a pilot, no further description of the interior navigation will be given here, and the reader is referred to the Sailing Directions accompanying the chart.

Baltimore is a city of considerable importance, situated on the River Patapsco, about 150 miles from the sea. Vessels of the largest size can reach the mouth of the river, and those drawing up to 25 ft. can reach the city at low water. Considerable commerce is transacted here, and the numerous wharves are well equipped with appliances. The dry dock will admit the largest vessels, and here repairs can be executed for ships and their machinery.

Alexandria, on the Potomac River, about 4 miles below Washington, can be reached by vessels drawing 20 feet. Here supplies of all kinds are plentiful, and a slipway can take up a vessel of 1,500 tons. Vessels drawing 14 ft. can reach the city of *Washington;* in the Report of the U.S. Naval Observatory to June, 1893, the position of the new observatory here is given as lat. 38° 55′ 14·68″ N., long. 77° 3′ 56″ W.

Newport News, situated on the North shore of Hampton Roads, is a comparatively new port, now much frequented, especially by steamers wanting coal. There is every accommodation for vessels of the largest size.

Norfolk, on Elizabeth River, has 24 ft. water in the approaches, and this is being improved by dredging. Various supplies can be obtained here.

Richmond, at the head of the James River navigation, had a least depth of 16½ ft. in the approaches at high water, and this is to be improved to 22 ft. by dredging.

Directions.—In approaching the Chesapeake, the ground off Cape Henry is in general coarse sand, with some gravel; but thence southward, to Cape Hatteras, it is commonly fine sand, with oaze.

Ships falling in with the land to the northward of the entrance should not stand inwards to a less depth than 7 fathoms, until they come into the latitude of Smith Island and Cape Charles, whence they may stand with safety into 5 fathoms.

In coming along shore from the southward, 7 fathoms will be a proper depth to keep in, until up with Cape Henry; whence falling into 8 or 9 fathoms, with a stiff or sticky bottom, you will be in the channel-way.

When you come in towards the land, to the southward of Cape Henry, you will have deeper water than when you are in the same latitude; as 21 fathoms, reddish sand, and pretty coarse; at 27 miles off there is 35 and 40 fathoms, fine gray sand.

The land is low and sandy; you cannot see it above 20 miles off. Cape Henry is low, but bluff, with a few trees at the seaside, and at a little distance from the water. It is moderately steep-to, excepting that a small shoal stretches out 2 cables from the shore East of the lighthouse, and there is nothing to hinder a ship from passing into Lynnhaven Bay, where there is soft ground, and from 4 to 6 fathoms of water. The bank, called the Middle Ground, is about 5 miles northward of the cape.

When coming from sea, in the latitude of Cape Henry, 36° 55′, you will meet with soundings, as above described. You may readily ascertain when in soundings by the muddy colour of the water. In clear weather the land of Cape Henry may be seen from the depth of 10 or 11 fathoms, regular soundings, which extend 15 or 18 miles to the southward of the cape; more to the northward the soundings are irregular and coarser, as above described.

In coming in for the Chesapeake, you may advance to Cape Henry, but cautiously avoiding the *Middle Ground,* which occupies so large a portion of the entrance, and which may be still increasing. With a northerly wind you may approach this bank to the depth of 5 fathoms. To the southward of it you find 12 and 13 fathoms, as well as in the channel between it and Cape Henry. This channel has a depth of 8 fathoms close to the cape.

With a fair wind you may run in with the lighthouse bearing W. by N.;

and, with a turning wind, you may stand to the southward until it bears N.W. by N., and to the northward until it bears West.

If requisite, you may run in with the lighthouse bearing West, as this course will lead to the channel-way, in from 6 to 10 fathoms, sticky bottom, as before mentioned. It is then proper to take soundings towards the southern shore; and, in order to do this, steer West, until you have advanced to a short distance from the lighthouse; then, rounding the point, you may haul into *Lynnhaven Roads*, and anchor in 7 to 4 fathoms.

Tides.—It is high water in the entrance of the Chesapeake, on full and change, at 8^h; the rise is only about 3 ft., but it is considerably influenced by the wind.

From Cape Henry, in lat. 36° 55′, to Cape Hatteras, in 35° 15′, the coast trends nearly S. by E. ½ E. This coast presents but few features, beyond the lighthouses, by which it can be recognised from passing vessels, and has no maritime interest whatever. It mainly consists of a narrow belt of low beach or sandhills, enclosing the extensive sounds or lagoons which form the sea face of North Carolina, such as *Currituck*, *Albemarle*, and *Pamplico Sounds*, &c. Caution is necessary not to mistake the higher inland for the coast. The soundings decrease regularly towards the shore as far as Wimble Shoals, or for a distance of 85 miles, except in one spot 22 miles South of Cape Henry, where a projecting 15-ft. shoal lies 1½ mile off the beach. For the rest, the 10-fathoms line is about 6 or 8 miles off, and 5 fathoms at 2 miles off. Some remarks on the Currents near this coast are given previously, on pages 439—440.

Currituck Beach Lighthouse, 35 miles from Cape Henry, is a red tower 150 ft. high, showing a *fixed bright* light, varied by a *red flash* every 1½ minute, visible 19 miles. Near it are some high white sand-hills.

Body Island Lighthouse, 35 miles farther on, is 150 ft. high, painted in black and white bands, and shows a *fixed bright* light, visible 19 miles.

Wimble Shoals, in the vicinity of which many wrecks have happened, lie off the coast of North Carolina, between lat. 35° 30′ and 35° 34′. On and around the shoals the bottom is very uneven, varying suddenly from 8 to 10 fathoms, and from 4 to 5 fathoms. The least water found on the shoals is 3½ fathoms, and their outermost limit is nearly 4 miles from the coast. No vessel drawing more than 18 ft. should pass in less than 11 fathoms water, either around the Wimble or Hatteras Shoals.

The *Currents* hereabout are governed by the wind, and are very strong, making heavy rips, which have every appearance of shoals to those who are not familiar with them. Sometimes the current begins to run quite strong twenty-four hours in advance of the wind at the same place. The storm, which is sure to come, always sets in from the direction in which the current has started.

Cape Hatteras, although not conspicuous for its elevation, being only a low sandy spit, gradually extending to the southward, is very remarkable as being a turning point in the East coast of the United States. The shores on either side are purely diluvial, formed and extended by the action of the currents which drift past them. Lying upon the line of junction between the two Wind and Current systems, where the East and West tendencies divide, we here meet the first evidence of the conflict between them in the singular line of shoals which projects at right angles to the line of coast—an evidence of the conflict between the Gulf Stream and the southerly Arctic Current, coming from high northern latitudes.

The Lighthouse on Cape Hatteras is 189 ft. high, painted in black and white spiral bands, and stands 2 miles North of the extreme point. It shows a *flashing bright* light every 10 seconds, elevated 185 ft., and visible 20 miles. Near the extremity of the point a *fixed bright* beacon light is shown, which bears S. ¼ W. from the high light.

The Hatteras Shoals are most dangerous. A spit runs off 1½ mile S.S.E. of the beacon light, and detached shoals extend for 8 miles to the S.E., the *Outer Shoals* having only from 9 to 15 ft. water on them. *Diamond Reef*, with 9 to 12 ft. least water, is separated from the Outer Shoals by a 6-fathoms shoal, 2½ miles wide. The sea breaks furiously over all these shoals. In May, 1894, works were commenced for erecting a lighthouse on the S.E. part of the Outer Diamond Shoals.

To clear the Outer Shoals, in approaching them from the northward and eastward, bring the lighthouse to bear West, in 12 to 10 fathoms water, when run South, keeping in not less than 10 fathoms, until the lighthouse bears N.W. ½ N., when any course South of West may be steered with safety. In coming from the southward and westward, keep in not less than 10 fathoms, until the lighthouse bears N.W., when any course eastward of North may be steered. The beacon light and the high light in one clears all to westward. As 10 or 11 fathoms may be found westward of the shoals, in going outside of them from the southward and westward do not approach the land to the southward of the cape nearer than 8½ to 10 miles.

In bad weather, and especially at night, do not approach the Outer Shoals nearer than 15 fathoms water from the northward and eastward, and 12 to 11 fathoms from the southward and westward. It is necessary to watch the bearings of the lighthouse, and keep the lead going in beating round or between the shoals. In approaching the shoals at night, or in bad weather, if the lighthouse has not been seen before night, it will not be prudent to run in for it.

Between Cape Hatteras and Cape Lookout, the next projecting point, a long sweep of low narrow beach, which separates the ocean from *Pamplico Sound*, extends in a curve for 66 miles. The soundings all along, between the shoals extending from the two capes, are regular, gradually diminishing from 14 and 15 fathoms to 5 and 6 fathoms near the shore, all sandy ground. At 26 miles W.S.W. of Cape Hatteras lighthouse is a shallow inlet into Pamplico Sound, named *Ocracoke Inlet*. Shallows reach 2 miles off, and on the eastern side of the inlet is a white tower, 65 ft. high, showing a *fixed bright light*, elevated 75 ft., and visible 14 miles.

CAPE LOOKOUT is marked by a lighthouse tower 150 ft. high, 2½ miles N.N.E. of the extreme point; it is painted in black and white chequers, and shows a *fixed bright light*, visible 19 miles. The light may be seen from off the outer shoals; but vessels passing are recommended rather to trust to the lead than to making the light. The land is so low, that by day it is not visible more than 4 or 5 miles from the deck.

Breaking shoals extend for 7 miles S.S.E. from Cape Lookout, and about 2¼ miles farther out is a 2-fathoms patch, 10½ miles S. by E. ⅓ E. from the lighthouse. The broken ground extends to latitude 34° 28′; in this parallel there is 10 fathoms water, and thence to the edge of the Gulf Stream the soundings gradually increase to 25 fathoms. From the outer part of Cape Hatteras Shoals the outer part of Cape Lookout Shoals bears S.W. ¾ W., distant 66 miles.

Beaufort Harbour, 8 miles N.W. of the South spit of Cape Lookout, affords shelter from all winds, and is easy of access, having about 15 ft. over the bar at low water. It can be entered with all winds except those between North and West.

CAPE FEAR is the south-western extremity of another of those long beaches which characterise this portion of the American coast. It bears S.W. by W. from the spit of Cape Lookout, distant 82 miles, but the shore recedes 18 miles inward from the direct line. The low sandy point known by the name of Cape Fear, is the S.E. extremity of a marshy island called *Smith Island*, which forms the South side of the entrance of *Cape Fear River* and the port of *Wilmington*. This town lies 21 miles up the river, and can be reached by vessels drawing 16½ feet.

Bald Head Lighthouse, on the western end of Smith Island, is a white tower 96 ft. high. showing a *revolving bright* light every half-minute, elevated 99 ft., and visible 16 miles.

Frying Pan Shoals, a very remarkable line of reefs, run in a S.S.E. direction for 16 miles from Cape Fear. They are exceedingly dangerous, and off their outer end is a *lightvessel*, showing two *fixed bright lights*.

In passing Frying Pan Shoals, vessels of heavy draught should keep in from 15 to 18 fathoms, especially in threatening weather, and under no circumstances run into less than 10 fathoms. In fine weather, steamers may cross the outer end of the shoals in 10 fathoms. The soundings, in approaching the shoals from the eastward, are regular, but from the westward they are irregular.

The Currents on the coast between Cape Fear and Cape Hatteras vary with the winds. During summer, when the prevailing winds are southwesterly, the current sets in the direction of the coast to the eastward; but, when the southerly wind ceases, the current suddenly changes, and this change frequently appears before the change of the wind.

When sailing towards these coasts, it is prudent to keep nearly a degree to the southward of the latitude of the place you intend to make, until you reckon yourself on the edge of the *Gulf Stream*, when you must be directed by judgment, according to circumstances. Do not, if possible to avoid it, sail to the northward of 33° 20′, or at the highest 33° 25′, until you attain 10 fathoms of water. In this depth you will be within the South or outer end of Frying Pan Shoals. In approaching the coast in 33° 20′, your first soundings will be from 30 to 35 fathoms; in this depth you will be very near to the inner edge of the Gulf Stream. You will have fine gray sand, with black spots, when you get into 17 fathoms; there is a long flat in this depth of water. In steering West, you will, for the first 15 or 18 miles, shoalen the water very little. When you come into 14 fathoms, you shoalen your water quicker, but gradually. You will see the land from 10 fathoms of water, if the weather be clear, and may then be sure that you are within the Frying Pan. To the westward of N.W., no land can be seen, when without the shoals.

From Cape Fear the coast again forms a sweep of curved beach, called the *Long Bay*, and at 81½ miles S.W. ¾ W. from it is Cape Roman, or Romain. At 14 miles N.E. by N. from the latter is the entrance of *Winyah Bay*, which is formed by the estuary of several rivers; *Georgetown* is about 10 miles up it. The bar has about 8 ft. over it at low water, and a *fixed bright light*, visible 15 miles, is shown on the East side of the entrance, from a white tower 82 ft. high.

The streams of the numerous rivers which fall into the estuary of Georgetown, with that of the next great river, called the *Santee*, have formed the extensive flats originally called the Shoals of St. Roman. These flats border the coast in a S.S.E., S.W., and West direction, for not less than 33 miles, taking the extent of their outer edges; and off the mouth of the Santee, the extent from the shore is not less than 7 miles. Vessels passing should not approach them, in the vicinity of Georgetown, nearer than into 6 fathoms; nor towards Cape Roman into less than 7 fathoms. The muddy appearance of the water hereabout may frighten strangers, but no real danger is to be apprehended. The land is an extensive assemblage of low islands, and is scarcely discernible from the outer extremity of the bank.

CAPE ROMAN is very improperly called a cape, being very low land, without either tree or bush, and appears at a distance like a sand left dry by the tide. About 2 miles W.N.W. of it, on *Great Raccoon Kay*, stands a red brick lighthouse, 150 ft. high, which exhibits a *revolving bright light* every minute, visible 18 miles. Near it is the old white tower, 65 ft. high.

Cape Roman Shoals extend for 5½ miles S.E. by E. ½ E. from the lighthouse, or 4 miles from the South spit of the Cape Island, having a depth of only 7 ft. on the extremity. These shoals are of a very dangerous character, lying directly in the track of coasters, and shoal very rapidly from 6 fathoms to 3 feet. With moderate winds from N.E. or West, the sea does not break upon them, but with winds from S.W., round by South, to the East, they are shown by the breakers on the seaward side. Inside the outer shoal there is a 15-ft. channel, nearly 2 miles in width, and a 6-ft. channel from the S.W. leads to the harbour inside the cape.

Vessels of heavy draught should not approach Cape Roman within 8 fathoms water, there being a 5-fathoms bank outside of the shoals.

From Cape Roman the entrance of Charleston Harbour bears S.W. by W., 29 miles. The land between is alluvial, and forms numerous low islands—an extension of the famous Sea Islands—the principal of which are named Bull, Capers, Devies, Long, and Sullivan Islands. Flats extend from all these isles, along which the soundings are regular. *Bull Island* appears very bluff, with red sand-hills, and shoal water extends 3½ to 5 miles off it. On it is a brick lighthouse, 35 ft. high, showing a *fixed bright light*, visible 12 miles.

Rattlesnake Shoals.—A spit extends 5 miles E. by S. from Sullivan Island, and forms the North side of the entrance to Charleston; close to the edge of it the depth is 5½ fathoms. Its outer extremity is marked by a *lightvessel*, showing two *fixed bright lights*.

When Charleston churches are seen to the northward of Sullivan Island, you will be on the edge of the Rattlesnake; and when the churches are open to the southward of Sullivan Island, you are clear of that shoal, or Fort Moultrie bearing W. by N. clears it to the southward. You should approach no nearer to this bank than in 5 fathoms of water.

CHARLESTON, the principal seaport and town of South Carolina, is situated on a low tongue of land at the confluence of the Wando, Cooper, and Ashley Rivers, about 6 miles up the harbour. Vessels drawing 16 to 17 ft. can cross the bar at high water, and proceed up to the city wharves, but the aid of a pilot is absolutely necessary, owing to the shifting nature of the channels. Supplies of all kinds, including fresh water, can be obtained here, and there is a good hospital. Cotton, rice, and phosphate rock are the chief exports, and vessels shipping the latter are warned of the unhealthy nature of the rivers where it is found, during summer and autumn.

The entrance of the harbour is between Sullivan Island on the North, and Morris Island on the South, the opening being 1¼ mile wide. The banks, across which the entrance channels run, reach 3 miles from the coast, to the depths of 3 and 4 fathoms, and nearly in the middle of the entrance is the famous *Fort Sumter*. Formerly there were several shifting channels over the shoals, but works are now in progress, by the construction of two breakwaters, to confine the stream to the Swash Channel, so as to deepen it, as so successfully done at the Mississippi. There is anchorage in 5 fathoms, at low water, with a soft sticky bottom, good holding ground, outside the bar, with the leading lighthouses on Morris Island in line.

Charleston Lighthouse, on the South end of Morris Island, is a handsome tower, 150 ft. high, painted in black and white bands. From it is shown a *fixed bright* light, elevated 155 ft., and visible 19 miles.

Fort Sumter Light, shown from a white framework on its N.W. side, is *fixed bright*, elevated 51 ft., and visible 13 miles. Several beacon lights are shown on *Sullivan Island*, on the opposite side of the entrance.

On *St. Philip's Church* steeple, in the city, is shown a *fixed bright* light, elevated 140 feet. This in line with Fort Sumter light, bearing N.W. by W. ½ W., leads through Swash Channel, between the breakwaters.

Swash Channel is marked by *buoys*, the outermost being a *black bell* buoy, in about 3 fathoms, on the line of the leading mark given above. In 1893, it was announced that within three years it was expected this channel would deepen to at least 21 ft. at high water, and eventually to 25 ft. or more. Consequently, the old Main Ship Channel will then be superseded by this more direct channel.

Numerous other lights are shown besides those described above, and these and other details are given in Findlay's "Lighthouses of the World," and in the Sailing Directions accompanying the chart.

It is high water, at the city, on full and change, at $7^h\ 24^m$; springs rise 5½ ft., neaps 5 feet. Strong or long-continued westerly winds reduce the water on the bar by from 1 to 2 feet.

The whole of the coast of South Carolina, South of Charleston, and all of Georgia, is low, and bordered with extensive shoals, consisting of a range of islands called the *Sea Islands*, which give their name to the famous cotton grown on them. From off Charleston Bar, in 5 fathoms of water, to North Edisto Inlet, the course is S.W. ½ W., and the distance 19 miles. This course will carry you clear of the shoals which lie off Stono Inlet; and which lie farther out than any other that are in your way to Edisto. The least depth found on this track will be about 3½ fathoms at low water.

Directions for the ports of the United States South of this are given in the Sailing Directions accompanying the Chart of the Coasts of the United States, and that of the West Indies, &c. Remarks on the Winds are given on pages 150—152 and 216, and instructions for the navigation of the West Indies generally are given on pages 511—538. To these the reader is referred for further information.

SECTION IV.

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1.—AN ACCOUNT OF THE SCATTERED ROCKS, SHOALS, AND VIGIAS, IN THE NORTH ATLANTIC OCEAN.

In the earlier editions of this work, the present section was in many respects a very unsatisfactory portion of it. To deal with the conflicting and imperfect accounts which often arose of the discovery of new shoals and dangers was most perplexing. But, since the greater precision introduced into navigation by the use of steam, these doubts have been dispelled, in most or in very many instances, by the direct test of the deep-sea sounding machine; and the testimony thus afforded, as to the non-existence (at least, in the assigned position) of many of the formidable reefs announced in perfect good faith, has led many to doubt the authenticity of the whole range of reported rocks.

The Chart of the North Atlantic Ocean, formerly disfigured by numerous reported rocks, shoals, and *vigias*,* now retains but few of them. Owing to the numerous lines of soundings made by war-ships and surveying vessels of the maritime powers, together with the equally or perhaps more valuable researches of telegraph cable-laying ships, and the fact that the ocean is now so furrowed by the tracks of innumerable steamers, there is but a small chance of any *doubtful* danger remaining as such. The earliest expedition, undertaken to disprove these numerous reported dangers in the North Atlantic, was that sent out by the United States Government in 1851-2, in the brig *Dolphin*, Lieut. Lee, commander, and it is gratifying to us to record that a former edition of this work, the "Atlantic Memoir" of 1845, was made the basis of these experiments.

Nevertheless, however much may have been done, the subject cannot be dismissed until a satisfactory and systematic examination of the whole bed of the ocean has been made. Until this has been done, we cannot pronounce absolutely that it is free from isolated dangers. The enumeration of them, therefore, will be continued in this work for the present, not with the idea of inducing too much caution, but as a reference to show that they have not been overlooked.

In a subsequent section, the subject of deep-sea soundings will be discussed. Its great importance, in relation to the present topic of doubtful rocks and shoals, is manifest, as it is almost the only test which is conclusive.

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* VIGIA, a Spanish word, literally signifying Watch, or Look-out, was generally in the charts attached to spots supposed to be dangerous.

An isolated rock is a very difficult matter to detect; and even the most laborious surveys have failed sometimes to find such. Many examples might be cited of this. Thus, Lewis Rock, the dangerous mid-channel rock in the entrance of Milford Haven, occupies what was supposed to be deep water, till accident made it known. Pin Rock, a similar very dangerous pinnacle, was discovered in the entrance of Dartmouth Harbour; Lee Rock, another, lies off the South end of Lundy Island, in the anchorage. A man-of-war was very nearly wrecked on an unknown rock in the centre of Braye Roads, Alderney, where our Government had expended enormous sums in making shelter. The ship in which the Prince of Wales visited Canada struck outside a buoy in the St. Lawrence. Another rock was overlooked in the survey of Tenerife, at its East end. Several most dangerous rocks were found after the survey, in the entrance of Port Phillip, South Australia. The same in the entrance to San Francisco.

A still more recent and convincing proof of the difficulty of finding submerged pinnacles is that of the discovery of *Avocet Rock*, in the fairway of the Red Sea, in 1887. In that year, two steamers struck on this unknown danger, both foundering in consequence. The officers of H.M.S. *Flying Fish* spent several days fruitlessly searching for it; later on, H.M.S. *Sylvia* scoured the locality for *six weeks*, finding no danger; and it was ultimately discovered by H.M.S. *Stork, not more than 300 yards from where the Sylvia had anchored.* It had only 15 ft. over it at low tide, with 28 to 30 fathoms around.

All these, and many other examples, show the extreme difficulty of pronouncing absolutely, on the non-existence of an isolated shoal, if a pinnacle of rock may not be found with the very close search of skilled surveyors, and pass quite unnoticed in a channel-way. Besides, some of these vigias may have ceased to exist, after having appeared for some time; as, for instance, the islands and reefs which have risen from the sea among the Azores, and afterwards disappeared, as narrated in previous pages.

We now proceed to give some examples of the old reports, which proved to be unfounded, for the benefit of those who may happen to come across similar appearances. The accounts given were frequently very vague and ambiguous, and in some cases evidently referred to floating objects, such as trees, which have occasionally been seen floating about with barnacles attached to their branches.

As a monition against too hastily forming conclusions from mere appearances, we here add, that an old friend of ours, in crossing the Atlantic, was once alarmed by the sight of breakers at no great distance. Instead of coming home with an imperfect report, he very properly sent out a boat to examine them, and found that they were caused by a floating body, thickly covered with barnacles, &c., to which a hatchet was applied, and soon disclosed a cask of wine, which proved to be excellent Burgundy. It had, no doubt, been floating about for many years, and during the time had probably been the prolific parent of a number of *vigias*, &c. Capt. Hamlin, in the brig *Recovery*, likewise picked up a hogshead of claret, which had been a long time in the water, and worm-eaten nearly through.

It is, moreover, possible that navigators, at a certain distance, may have mistaken whales. M. de Chabert, in his voyage to America, in 1741, for the purpose of making astronomical observations, being at the distance of 200 miles from Corvo, of the Azores, descried a dusky body, over which hovered a number of gulls, a bird seldom seen at such a distance from land; at first he imagined it to be a rock, but on coming near, in order to observe it more closely, he found it to be the dead carcase of a whale of monstrous bulk.

We have shown in our works on the other great Oceans, how easily an animated as well as a lifeless being may be mistaken for a rock. At noon, on August 1st, 1818, the *Northampton*, Captain Tebbut, on her passage to India, was in lat. 40° 45′ S., long. 24° 3′ E. On the next day an object appeared right ahead, like a boat; on nearing, it looked like the wreck of a vessel, *two parts being above water*, at two ships' lengths from the lee-bow. The barnacles could be distinguished by the naked eye; but, when abeam, the creature *went down*. It proved to be a thrasher. Captain Tebbut says, "At the time we came up with the animal, the two parts above water seemed to be like a wreck, bottom upward. When I first saw the barnacles, the part covered with them looked rugged, and I was firmly of opinion that it was a rock above water; so much so, that I looked over the lee-bow to see that we were clear of it, ordering the man to starboard the helm."

A similar instance is recorded in the "Journal of the Royal Geographical Society." "A frigate was one day running into the Rio de la Plata, with her studding-sails set, when the look-out man at the mast-head reported breakers on the bow. The captain, believing that such a danger could not have escaped the notice of the Spaniards, and having also a tolerable chart of the river, suspected it must be some floating object, and ordered the ship to be steered directly for it. The officers were on the alert; glasses were frequently directed to the spot, and all concurred in representing it as a rock a little above water. Anxious looks were directed to the captain, whom they now considered as unnecessarily running into danger; but that officer kept carefully watching his approach, and, as the studding-sail boom was just over it, the cetaceous monster (for such it was) hastily made off; and, rising again to blow, finally disappeared. It was observed to have an excrescence on its back, covered with shell-fish. The sea broke gently on its weather side, and appeared becalmed to leeward; and so perfectly did it resemble a rock, that, had the vessel passed at a distance without disturbing it, there can be little doubt but it would now have had a place upon the list of vigias.

"It is to be observed, in this case, that there was only a little ripple about the body, but no breakers; and this circumstance had not escaped the intelligent eye of the commander."

The *dead* carcase of a whale may even approach nearer in appearance to a permanent danger than a living one. Captain Vidal, in H.M.S. *Styx*, while passing from Terceira to St. Michael's, on July 20th, 1844, the masthead man reported the appearance of breakers on the starboard bow; the wind was West, and there was a little swell. "I have no hesitation in stating that this object (a dead whale) so much resembled a sand-bank, or a tide-rock at low water, that had I left it unexamined I should certainly have reported the probability of its being either the one or the other, and in so doing I should have added another vigia to those which disfigure the charts of the North Atlantic Ocean."

A similar instance was forwarded to us by Capt. T. Smith, commanding the *Liverpool*:—"On June 8th, 1870, at 5.30 p.m., in lat. 40° 48′ N., long. 41° 26′ W., the chief mate reported an ice-floe on the lee bow; on going on deck I perceived, about a quarter of a mile to leeward, what appeared to be a mass of ice, with some dark-coloured substance on the centre of it; but, taking my telescope, I perceived it to be a dead carcase, probably that of a whale, with numerous birds swarming around it. The upper portion, being dry, was probably dark-coloured from exposure to the sun, as the blubber appeared to be off, and the colour dark brown, but all that was awash was perfectly white, with several undetached fragments floating around it, the whole mass heaving and undulating with the swell of the sea, which was washing against it, but not breaking; the *white* portion, however, might easily have been mistaken for broken water at a greater distance, and the *dark* portion for a *rock awash*. I doubt not but many of the reported dangers mentioned in your valuable 'North Atlantic Memoir,' and other Directories, have no other foundation; the visible portion might be about 40 feet by 20 feet in extent."

In July, 1870, when in 4° N., 24° W., a captain remarks, in his log:—"Passed through a shoal of *Bonitos*; there must have been thousands, and so closely were they packed, that they tore the water into a white sheet of foam. At a distance they might have been mistaken for a reef flush with the water, having an area of about 100 square yards."

The following, also, at a distance, might deceive. In September, 1864, when in 6° N., 31° W., a captain remarks:—"Some *porpoises*, cutting extraordinary antics like acrobats." It is probable they were throwing themselves a great height out of the water, and allowing themselves to fall (as it were lifeless) on their sides, making a great splash. At any rate, this is not an uncommon sight, and it is supposed by some that it is their way to rid themselves of parasites.

In every event, however, it is always the safer course, in matters of this nature, to err rather by marking too many than too few, especially when we make known, as we have done, the authority that we rely on for the existence of each. Every one, of course, is free to act according to his own judgment. But on *all future announcements* of the discovery of rocks or shoals, it is absolutely necessary that they should be tested by the *sounding lead* and close examination. Without these, they will not be considered as authentic.

In the first instance we give an account of those shoals which are well known, and also of those which are not absolutely disproved, though in many cases the question of their existence rests on the most slender grounds, and it is just possible that some may be better authenticated hereafter.

1.—TO THE NORTHWARD OF LATITUDE 40° N.

NUN ROCK, off Cape Wrath, in lat. 58° 52½′ N., long. 4° 58′ W.

This rock is a very dangerous isolated patch, bearing N.E. by N. ½ N. (*N. 5° E. true*) from Cape Wrath, the N.W. part of Scotland, 15 miles distant. It is of small extent, not half a mile in diameter, with deep water all around it, and with 3¼ fathoms, or, as some say, not more than 2½ fathoms, over it. It has been seen to break very high at half-tide. It is high water, on full and change, at 11^{h}; springs run 4 miles an hour, and neaps 2 miles, the flood setting to the eastward.

Rona, *Sulisker*, and other isolated rocks lying westward of the Orkney Islands, are described in the Sailing Directions accompanying the Chart of the North and West Coasts of Scotland.

NORTH SHOAL, West of Orkney, lat. 59° 13′ 23″ N., long. 3° 35′ W.

This is one of the most dangerous shoals around the British Isles, as it is singularly isolated, and not larger than half the size of a boat. It has but 7 ft. least water, with 10 to 30 fathoms around it, and bears from Noup Head, Westra, West, northerly, distant 17 miles; from the Brough of Birsa, N.W. by N., northerly, 9 miles; and from the Old Man of Hoy, N. ⅞ E., 20¾ miles. In fine weather it is distinctly marked by the ripple of the tide, and in rough weather the sea breaks heavily over it.

Roche Bonne and the Banche Verte, in the Bay of Biscay.

These two rocky shoals, lying a short distance apart, westward of the Ile de Ré, have been already noticed, in the description of the coasts, on page 598.

Jones Bank, lat. 51° 23′ N., long. 14° 25′ W.

Notwithstanding the pains taken to ascertain the exact limits and character of the edge of the bank of soundings off the West coast of Ireland, it does not appear to have been definitely determined. The following are the particulars of a shoal cast of 30 fathoms, about 180 miles westward of Cape Clear, near the S.W. verge of the bank; a depth of 470 fathoms was found 16 miles to the westward of this position.

Jones Bank, as this may be called, was found by Captain David Jones, of the barque *Achilles*, on August 18th, 1864. The vessel was becalmed, and the lead was hove, and showed 30 fathoms most unexpectedly, as above stated. He plumbed several times, and held on to the line, and found the lead at the bottom to drag over the uneven parts of the rock, and brought up a stone sticking to the lead.

Now, when the nature of the adjacent coast is considered, it may be quite possible that this is an isolated hill of trap rock, like the lofty Skelligs, and may have a much less depth on some of its peaks. It is possible that the reported *Brasil Rock*, whose existence in the assigned position was disproved by the officers of H.M.S. *Porcupine* finding 2,350 fathoms there, may have some connexion with this.

PORCUPINE BANK, *to the Westward of Ireland.*

During the examination of the sea-bed to the westward of Ireland, by the officers of H.M.S. *Porcupine*, for the purpose of finding the best route for laying the first Atlantic telegraph cable, the tail of a detached bank was unexpectedly crossed, on August 8th, 1862. "Carrying out a line of soundings on the parallel of Slyne Head, at the distance of 120 miles to the westward of it, we crossed the tail of a bank of 82 fathoms, coarse gravel. This being entirely new, it was named *Porcupine Bank*. It will be of use to vessels bound to Galway from the westward, as a means of ascertaining their position by the lead. The bottom, both to the northward and southward, is deeper, being composed of fine dark sand, while the bank is composed of gravel and coarse sand." This bank is about 40 miles in extent, East and West, with 150 to 180 fathoms to the eastward of it, while to the westward it deepens rapidly to 300, 500, and 1,500 fathoms.

DVINA ROCK (?), off Cape Finisterre, lat. 44° 43′ N., long. 9° 37½′ W. (*Doubtful.*)

This announcement we received from Captain Grote, of the Russian Imperial Navy, when in command of the *Dvina*, the vessel which was hardly chased by our men-of-war in the Pacific during the last Russian war.

"On Jan. 14—26, 1853, the foretop look-out descried breakers right ahead, and we discovered it to be a rock, on a level with the water, in lat. 44° 43′ 6″ N., long. 9° 37′ 23″ W. The sea was perfectly white with foam for about 200 fathoms." Captain Bessarabski made it to be in lat. 44° 48′ N., long. 9° 43′ W. A depth of 1,820 fathoms has since been found very near this position, and considering that it lies so contiguous to one of the main routes of commerce, its existence is very improbable.

The charts of Van Keulen, of the last century, showed a rock in 44° 43′ N., long. 11° 22′ W.; but it has long been omitted as not authentic.

MIDGLEY SHOAL, in lat. 44° 9′ 30″ N., long. 22° 57′ 45″ W. (*Doubtful.*)

Captain Thomas Midgley, in 1838, reported as follows:—"On June 14th, 1838, at 2.40 p.m., on my passage from Africa to Liverpool, I suddenly fell in with a large patch or belt of discoloured water, of a dirty gray appearance, much resembling river water, and *rippling very much*, as if upon a shoal bank. No rock or danger could be seen from the mast-head, but the water appeared very much discoloured for more than half a mile in breadth, as far as the eye could reach, in a direction N.W. and S.E. by compass." Position as above.

The late Captain Midgley was a man of perfect veracity, but the appearance might have arisen from other causes.

GOUGH OR HARRISON ROCKS, in lat. 40° 28′ N., long. 30° 0′ W. (*Doubtful.*)

Particulars of these reported dangers, said to lie about 90 miles north-eastward of Corvo, one of the Azores, are given previously, on page 753. We may here draw attention however, to a remarkable report from the captain of the steamer *Zaragossa*. He stated that in September, 1879, one morning he and his officers passed close to a stranded and deserted wreck, in lat. 40° 20′ N., long. 36° 49′ W., hard and fast ashore upon a reef, but did not board her, and no mention is made of soundings. The account appears in the "Nautical Magazine," February, 1885, page 103.

MOSSMAN ROCK, lat. 43° 41′ N., long. 28° 51′ W.

The harbour master of Hartlepool announced the discovery of a rock a few feet above water, by his brother, Captain Robert Mossman, in command of the *Edward Kenny*, April 22nd, 1854, in the above position. It was confidently believed to be a rock, but no means are stated to have been tried to test it.

The repeated announcements of rocks in this neighbourhood, although they hardly in any case appear to be seen again in the positions claimed for them, and the evidence of the deep soundings is against several of them, yet this repetition of discovery leads to the inference that some such rock as Mr. Mossman describes may lurk hidden here, and have given rise to these reports.

In 1850, soundings of 48 and 70 fathoms were reported by the captain of the *Chaucer*, about 60 miles south-westward of this position. Later examinations show a depth of 1,210 fathoms not far eastward of these reported soundings. On December 5th, 1892, no bottom was found in their vicinity at 125 and 135 fathoms, by soundings taken from the U.S.S. *Monongahela*, nor could any indication of shoal water be seen; the weather was fine and clear, and the sea calm.

SAINTHILL, BEAUFORT, OR MILNE BANK.

We have in this a very singular fact in hydrography. On two occasions very satisfactory soundings were obtained *near the same spot*, by British Naval officers, and yet both positions were unsuccessfully sought for by a third, as will be seen by the following:—

Lieut. A. Sainthill, R.N., commander of the ship *Beaufort*, on returning from Jamaica, on August 3rd, 1832, when in lat. 42° 37′ N., long. 41° 45′ W., observed the water to be discoloured; in consequence of which he twice tried for soundings, and found rocky ground at the depth of 100 fathoms. But in September, 1858, Commander Dayman tried and found no bottom with 3,000 fathoms up and down, in lat. 42° 7′ N., long. 41° 28′ W., about 35 miles to the S.W. This, however, cannot be considered as reliable, since more recent experiments show depths of 1,850 to 2,500 fathoms in this region.

Notwithstanding that these deep soundings, so near Lieut. Sainthill's position (of which, however, he was not confident to half a degree of longitude), would apparently disprove its existence, yet Lieut. Sainthill repeated his statement (in the "Nautical Magazine, 1859," page 209): "I am perfectly convinced that we touched bottom; what Captain Dayman would call an excellent up and down cast. The arming of the lead showed sharp rocky bottom of fine blueish ashes. The water was very much discoloured, which induced me to try for soundings, and my opinion is that we were over a submarine volcano in a state of eruption."

In 1864, Admiral Sir Alex. Milne, in H.M.S. *Nile*, also reported that he had found less water in the vicinity, his account being as follows:— "On March 28th, 1864, in lat. 43° 35′ N., long. 38° 50′ W., during the passage from Bermuda to England, the sea assumed a dark, dull lead colour, and soundings were obtained in [illegible] and [illegible] fathoms, and at 12 miles farther to E.N.E. [illegible] fathoms, fine sand and ooze. I am inclined to think that a bank of some considerable extent exists in this locality, as the water for many hours previous to sounding was of the same peculiar tint, indicating soundings, and this appearance continued to the E.N.E. until the night of the 2nd instant. This morning we regained blue water, and with reference to soundings on the chart of 100 fathoms water (Sainthill, [illegible]), it strikes me as probable that this bank extends from long. 42° W. to 35° W., and from lat. 42° to 45° N."

This would appear to be quite decisive, yet the following extracts from the report of Commander W. Chimmo, R.N., who examined the vicinity, in H.M.S. *Gannet*, in July, 1868, will show that its true position has not yet been found:—"We now sailed East for the spot where Lieut. Sainthill obtained 100 fathoms, on sharp rocky bottom. At 2 p.m., on July 12th, we reached this position, and with a heavy weight 4,310 fathoms of line ran out, and no bottom! (This surely must be an error.)

"It was somewhat remarkable that about this place, within a radius of some few miles, many indications of shoal water had been from time to time seen and reported, one having as little as 35 fathoms on it. To one of these, called *Milne Bank*, with only 80 fathoms on it, found by H.M.S. *Nile*, in 1864, we were now steering. At 4 p.m., on July 15th, we were on the 80 fathoms. The rod and weight of 230 lbs. let go, and 2,280 fathoms ran out. There was no bank there. The rod brought up "oaze," abounding in animal, vegetable, and mineral!

"In September, another cast of the lead, on the position of the Sainthill volcano, quite disproved the existence of this vigia within a radius of many miles.

"Approaching Milne Bank for the second time, on September 3rd, in lat. 43° 40′ N., long. 38° 50′ W., the lead was again let go, and 2,700 fathoms obtained, the rod bringing up a small particle of Foraminifera. Near the supposed position of this bank we sounded at short distances for some days with more than 1,000 fathoms of line; but in no case was there any indication of it. The temperature here obtained, with new and delicate thermometers, at 2,000 fathoms was 42°—rather a higher temperature than expected. The air was 68°; the sea-surface 69°; while at 100 fathoms it had fallen 10°, and at 400 fathoms 20°! At 1,000 fathoms it was 43°, after which it fell but 1° in 1,000 fathoms.*

LAURA ETHEL BANK, lat. 46° 55′ N., long. 38° 50′ W.

In 1878, the captain of the *Laura Ethel* reported that he obtained a cast of 36 fathoms, sandy bottom, in the above position, which is about 250 miles *East* (true) of the Flemish Cap.

VIRGIN ROCKS, lat. 46° 26′ 57″ N., long. 50° 47′ 40″ W.

These rocks, forming a dangerous reef, 87 miles S.E. ½ E. from Cape Race, together with the surrounding dangers, are described in page 851.

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* See "Proceedings of the Royal Geographical Society," vol. xiii., 1869, pages 93—98.

WATSON ROCK, lat. 40° 18′ N., long. 53° 40′ W.

Captain T. A. Watson, of the *Harbinger*, reported that at 8 a.m., April 20th, 1824, in moderate weather, his vessel passed close to leeward of a rock, just even with the surface, and covered with weed, about 3 fathoms or more in diameter; it uncovered several feet in the hollow of the sea. The first officer and others also saw it, and on quickly heaving the lead no bottom was found at 90 fathoms. For several miles round it the water was dark, as if on soundings. He concludes his report by saying :—" During the many years (14) I have commanded a ship, mostly in the North American trade, I have seen various things in the ocean, and was too well acquainted to mistrust my eyes in this case. It is said that Daraith saw a danger not far from this; perhaps it may be a part of the same, as he represented it as very extensive. I am convinced we too often treat *doubtful dangers*, in charts, with indifference, because they are are not always seen by those who look for them; may it not be the case that ships sometimes are wrecked on them, and never heard of? However, I shall always dread the above danger when sailing in that part of the ocean."

Captain Lopez, of the Spanish ship *Santissima Trinidad*, reported that he saw Watson Rock on October 8th, 1875, and described it as being circular, black, and about 26 ft. in diameter, with two small peaks on its southern part. He lowered a boat and approached on the N.W. and S.E. sides to within 30 yards of the rock, and found bottom in 23 and 32 fathoms, but a little farther off he could get no bottom at 82 fathoms.

In 1879, the U.S.S. *Kearsarge* unsuccessfully searched for Watson Rock during two entire days, under most favourable circumstances of wind, weather, and sea, sounding frequently with 190 fathoms of line.

Dangers have frequently been reported in this region (see Anna, Hamilton, and Daraith Rocks, in subsequent Tables of Shoals, &c.), but considering how constantly this region is now traversed, it seems extremely improbable they can exist. Possibly, they may have been icebergs, floating low in the water.

CASHE LEDGE, lat. 42° 56′ N., long. 68° 51′ 30″ W.

This is a bank, with soundings under 50 fathoms, lying in the approach to Boston from the eastward, and on it are two rocky patches, with only a few fathoms over them. *Cashe* or *Ammen Rock*, one of these, is a dangerous reef, with very irregular soundings, having from 10 to 4¼ fathoms in the length of a boat. The least water on the rock is 26 ft.; a less depth has been reported by the fishermen, but they sound with their fishing lines, perhaps not accurately marked, and with a lead insufficient to press down or pass through the thick kelp which covers the rock. The extent, having less than 10 fathoms, is about half a mile N.W. by W. and S.E. by E., and very narrow. It is surrounded by deep water at a short distance, particularly on the S.E. side, where the depth increases suddenly to 60 fathoms. There is 17 fathoms within a cable's length of it, deepening in a short distance to 90 fathoms, on the western side. *Sigsbee Rock*, with 5 fathoms over it, lies near the centre of the ledge, 3¾ miles S.W. ¾ W. from Cashe Rock. On approaching this shoal, in depths of 60 to 35 fathoms, you may find brown sand, with black stones and broken shells; then 30 fathoms, where it becomes rocky. The currents on the ledge are exceedingly rapid and devious.

GEORGE BANKS.

These extensive banks are fully described in the Sailing Directions accompanying the Chart of the United States coast. They have been accurately surveyed by various officers of the U.S. Navy, and on them are several patches with less than 10 fathoms water, on which the sea breaks heavily at times, with depths of 15 to 40 fathoms between them.

George Shoal, the largest and most dangerous of these shoals, is 13 miles in extent N.N.W. and S.S.E., within the 10-fathoms line, and from 1 to 2 miles in width; the shoalest places are knolls of hard sand. There is a rip usually the whole length of the shoal, and, at times, heavy breakers in the shoalest places. The shoalest part has a depth of 12 ft. over it at low water, in lat. 41° 39′ 45″ N., long. 67° 44′ 45″ W. The northern extreme, with a depth of 6 fathoms, is in lat. 41° 46¼′, long. 67° 48½′; and the southern extreme, with a depth of 6 fathoms, in lat. 41° 33¼′, long. 67° 39′.

The least water on *Little George Shoal*, at the southern end of George Bank, is 5 fathoms, in lat. 41° 15′ 30″ N., long. 68° 0′ W.; and bearing S.W. ½ S., distant 27 miles, from the shoalest part of George Shoal.

Rogers Shoal, with a depth of 5¼ fathoms, at the S.W. extreme of George Bank, is situated in lat. 41° 11′ N., long. 68° 26′ W., 42 miles S.W. by W. ¾ W. from the shoalest part of George Shoal.

" The tides and currents on these far-famed shoals present no danger to steamers, the northerly set never causing any practical inconvenience. But with sailing ships the greatest vigilance is necessary, the preponderance of drift and set appearing to be decidedly northward. It is a weird place, full of tide-rips, breakers, and discoloured water, which in heavy weather occasionally make the navigator hold his breath when he sees the waves rearing and twisting around each other as if endued with life, or running against the wind with a comb of foam trailing behind them, more dangerous than a regular heavy sea to small deeply-laden coasters. During the winter months the New York pilots carefully avoid cruising in the vicinity; their well-appointed and well-handled little punts are scarcely safe amidst breakers where sand is lodged on the deck from a depth of 7 fathoms or more."—*Commander W. W. Kiddle, R.N.*, 1878.

NANTUCKET SHOALS.

These very dangerous shoals, lying immediately in the line of traffic of the coasting trade of the United States, have been described previously, on pages 865—866.

2.—BETWEEN THE EQUATOR AND LATITUDE 40° N.

Dædalus Rock, off Cape St. Vincent, in about. lat. 36° 30′ N., long. 9° 16′ W. (*Very Doubtful*).

The old charts of the Atlantic indicated a danger at the distance of 35 to 45 miles to the S.W. of Cape St. Vincent. This danger was omitted in the French chart of 1786, and subsequently in other charts, from the supposition that, if it really existed, it must have received some confirmation. But Captain Taylor, of the brig *Laurel*, of Whitby, reported that, in about 1813, the *Dædalus*, transport, struck on this rock, and received so much damage as rendered it necessary for her to put into Lisbon for repairs. Captain Taylor was in the fleet when the *Dædalus* struck.

The brig *Briton*, Captain Stokes, was also lost, in consequence of striking upon the rock, in December, 1821. After she struck she swang off, and he then immediately tried for soundings, but got none. Captain Stokes had not seen Cape St. Vincent, but supposed it at the time to bear N.E. by N. ½ N., distant 28 or 30 miles. These particulars were communicated by Captain Livingston, who says, "This information was given to me in Malaga, in September, 1822, by Captain T. Tankersly, of the schooner *Lord Mulgrave*, of London. Captain Tankersly added, that he had met with another master (name forgotten), who said he had observed the sea-weed on this rock; got out his boat, and held on by some of the weed. He supposed the rock to be about 50 yards in circumference."

Captain Livingston also wrote to us, October 28th, 1822, as follows:—"I have information on which I can rely, from a very respectable naval officer, whose name I do not consider myself at liberty to mention, that H.M.S. *Indefatigable*, commanded by Sir Edward Pellew, actually struck on the rock, or a rock, off Cape St. Vincent, and received some damage."

The existence of this rock was also affirmed on March 6th, 1839, by Mr. John Aves, commanding the schooner *Tantivy*, of Plymouth. At 9^h 30^m p.m., this vessel, on her voyage from Zante, passed close to the eastward of it; it was not seen till close aboard, and not avoided without difficulty. There was a swell from the N.W. breaking over it, and a sheet of foam, about 20 to 25 fathoms in circumference. The *Tantivy* stood in N.N.E. on the port tack, till 7 next morning, then tacked to the southward, passing the cape at the distance of about 2 miles. The rock was thus estimated to lie considerably to the eastward of its position, as shown by the chart, and to bear about *S.S.W.*, *true*, 37 to 40 miles from the cape.

That this rock does not exist in the position usually assigned to it in modern charts is proved by the following, which we translate from the "Annales Hydrographiques," part 3, 1875, page 473:—"The *Nautilus*, during her passage from Lisbon to Gibraltar, searched for Dædalus Rock over its reported position, 30 to 35 miles S.W. of Cape St. Vincent, in lat. 36° 30′ N., long. 9° 16′ W. Having previously determined the position of the ship by bearings of the land, she was steered direct for the N.E. portion of the area to be searched, and then cruised East and West, covering a distance of 315 miles, continually sounding. Of the 11 soundings tried, only one reached the bottom in about 350 fathoms, the others found no bottom between 90 and 130 fathoms. The weather was beautiful, with bright sunshine, the water of a deep blue, and the swell from the S.E. sufficient to indicate a danger by breaking over it. Four men were placed in the rigging, on the look-out for anything to indicate the danger, such as weeds, eddy, or breakers. But nothing was seen of the danger, and it was concluded that it did not exist, or, at any rate, not in its assigned position."

H.M.S. *Challenger* obtained a sounding of 1,000 fathoms, 30 miles N. by W. of the position assigned to this danger, and another of 2,500 fathoms at 50 miles to the W.S.W.

In connection with this, we may mention:—*Dario Rock*, reported to have been seen by the captain of the Spanish brig *Dario*, on April 25th, 1834, in lat. 37° 12¼' N., long. 9° 31' W. *Ugarte Shoal*, reported by Tomas Ugarte, of the Spanish lugger *Joven Enrique*, April 14th, 1832; in latitude 36° 38' N., longitude 11° 21' 38" W., he saw bottom of sand, with occasional black patches, and got soundings in 8 to 3½ fathoms. He also saw breakers, and estimated the shoal to be about 1 mile in diameter. *Garcia Guerra Rock*, in lat. 36° 36¼' N., long. 10° 51¼' W., on which the Spanish brig *Pelicano* touched, at 11 p.m., June 16th 1837. *Regueral Shoal*, on which a depth of 64 fathoms, shells, was found by the pilot Andres Regueral, July 11th, 1798, in lat. 36° 35' N., long. 11° 3' W.

These reports lead to the belief that near the parallel of 36° 35' N., between long. 9° and 11° W., dangers *may* exist, though careful search has failed to detect them. We have been somewhat diffuse, but these reports are from one of the great ocean highways, and here we must leave the subject for the present. It is a blot on the charts; but still a rock may exist hereabout similar in character to Gettysburg Bank. The question of its existence ought to have been completely set at rest many years since.*

GORRINGE or GETTYSBURG BANK, lat. 36° 32' N., long. 11° 35' W.

This bank, lying between Madeira and Cape St. Vincent, at about two-sevenths of the distance from the latter, was first discovered by Commander Gorringe, of the U.S. steam-sloop *Gettysburg*, in December, 1876, while engaged in carrying a line of deep-sea soundings between Gibraltar and the Azores for telegraphic purposes. It was afterwards carefully examined by the officers of H.M.S. *Salamis*, in March, 1877, during a period of four days.

The area of Gorringe Bank, within the depth of 100 fathoms, is nearly circular in shape, with an average diameter of 5 miles, included between the parallels of 36° 29½' and 36° 34½' N., and long. 11° 32' and 11° 38' W. The shoalest part, within the depth of 35 to 30 fathoms, appears to be a narrow ridge 2 miles in extent, running nearly East and West; the least depth of 30 fathoms being confined to a small patch in lat. 36° 31½' N., long. 11° 35½' W.

The nature of the bottom at depths under 50 fathoms was found to consist of rock and coralline matter; in depths exceeding 50 fathoms, pebbles, coralline substances, shells, and sand. Fish in abundance were caught on the bank.

Beyond the depth of 100 fathoms the soundings increase rapidly. The depth of 1,000 fathoms being about 5 miles in a northerly direction from the shoal ground; 6 miles in a southerly; 13 miles to the westward; and

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* Possibly this danger may have been a temporary one, of volcanic origin. On November 11th, 1858, at 7.45 a.m., the *Venus*, when 30 miles N.N.W. from Cape St. Vincent, was seized with a violent trembling, as if caused by some volcanic eruption; the shock was felt by all the crew, and lasted about 15 seconds, the noise resembling the rumbling of thunder. Volcanic material has also been found on Gorringe or Gettysburg Bank.

11 miles to the eastward. At 20 miles distant, in a north-westerly direction, a depth of 2,750 fathoms was found, and in a north-easterly direction, 1,640 fathoms.

The Tide was observed in H.M.S. *Salamis*, when at anchor on the shoal ground, on March 4th (spring tides), to set regularly N.E. and S.W., with a maximum velocity of about 1½ knot.

On June 26th, 1888, Captain Meister, of the Swedish frigate *Vanadis*, when in lat. 36° 32½′ N., long. 11° 37′ W., found 32 fathoms on this bank, bottom of small black lava stones, white and red coral, and coarse black sand. In 36° 34½′ N., 11° 38¼′ W., he found 120 fathoms, coarse clean coral sand, mixed with fine black lava, or black sand, and shells. Heavy overfalls were noticed on the bank. The above soundings indicate that this bank may be of volcanic origin.

JOSEPHINE BANK, lat. 36° 40′ N., long. 14° 10′ W.

This is a bank of 82 to 90 fathoms, discovered by the Swedish exploring vessel *Josephine*, in 1869. It lies nearly on the parallel of Gettysburg Bank, but 2½° farther to the westward.

SEINE BANK, lat. 33° 42′ N., long. 14° 18′ W.

In 1882, the telegraph steamer *Seine*, in carrying a line of soundings between Lisbon and Madeira, struck bottom on a bank about 7 miles in extent, rising suddenly from depths of 2,200 fathoms to 100 and 118 fathoms, rock and coral. The least depth found was 81 fathoms, in the above position, about 110 miles *E.N.E.* (*true*) from Porto Santo.

FALCON ROCK, to the Northward of PORTO SANTO.

This sunken rock, probably identical with the *Eight Stones* of the old charts, is described on page 757.

DACIA BANK, lat. 31° 15′ N., long. 13° 14½′ W.

This bank, reported by the telegraph steamer *Dacia*, in 1883, was examined by the French war-vessel *Orne*, in April, 1887, when soundings of 38, 12½, and 60 fathoms, sand and muddy gravel, were obtained on it, 12½ fathoms being found in lat. 31° 15′ 5″ N., long. 13° 40′ 20″ W., or about 100 miles northward of Alegranza, one of the Canary Islands.

CONCEPCION BANK, lat. 29° 55′ N., long. 12° 55′ W.

This is a bank lying about 40 miles north-eastward from Alegranza Island, on which a least depth of 84 fathoms was found by the telegraph steamer *International*, in 1883. There are soundings from 800 to 1,500 fathoms close around it, but about midway between it and Dacia Bank the depth is only 583 fathoms.

Constante Reef, lat. 37° 56′ 20″ N., long. 33° 4′ 3″ W.; Ferreira Reef, lat. 38° 26′ 44″ N., long. 30° 25′ 10″ W.; and other Doubtful Dangers around the Azores Islands.

On pages 751—754, we have given an account of the above and other banks and dangers reported near the Azores, whose existence has not been confirmed. These are *Kutusoff* or *St. Mary Bank*, *Tulloch Rocks*, *Keus* or *Europa Rock*, *Whale Rock*, *Gough* or *Harrison Rocks*, &c. The repeated accounts which have been given of earthquake phenomena hereabout ought to induce caution.

Chantereau Shoal, lat. 38° 27′ N., long. 38° 0′—41° 35′ W.

This shoal, described as a white rock, was said to have been seen by Captain Chantereau, of the ship *L'Auguste*, in lat. 38° 24′, long. 41° 35′, in coming from Martinique, September 6th, 1721, when the sea broke on it very much. It was again announced by Lieutenant E. Scott, commanding the *Princess Elizabeth* packet, April 24th, 1828, as in lat. 38° 16′, long. 39° 48′ 50″.

According to a notice in the *Derrotero de las Antillas*, dated Madrid, July 4th, 1846, a shoal or vigia was discovered at 3 p.m., May 21st, 1846, in fine weather, by Don Gabriel Perez, captain of the Spanish merchant ship *Leontina*, in lat. 38° 27′ N., long. 37° 57′ 10″ W., according to observations made shortly before seeing the rock, and confirmed by chronometer in making Graciosa (Azores) a few days after.

Here we have three announcements of dangers of similar character in comparatively close proximity; if a danger exists, they are probably the same. We have no further evidence in its favour or to contradict it, but about 25 miles eastward of the last position a depth of 2,200 fathoms has been found.

Marsala Bank, lat. 33° 55′ N., long. 34° 17′ W.

Captain G. B. Fasce, of the Italian ship *Marsala*, reported:—On April 19th, 1877, being in lat. 33° 42′ N., long. 34° 25′ W., observed a discolouration of the water, and in lat. 33° 55′ N., long. 34° 17′ W., sounded in 82 fathoms, hard bottom; a second cast, in lat. 34° 1′, long. 34° 9′, found no bottom at 123 fathoms. The water resumed its blue colour after sailing a few miles. A depth of 1,700 fathoms has been found close to the S.W. of this position.

Romantico Rock, lat. 31° 43′ 30″ N., long. 33° 43′ W.

This was reported to have been sighted from the Spanish barque of that name, April 3rd, 1886, about 500 miles S.S.W. of the Azores. It was 64 ft. long, N.N.W. and S.S.E., and 4½ ft. above water at its S.W. end, with a rocky reef above water on its North side. It appeared to be of red stone, of a circular form, with patches of grass or weed on it. Could this have been an iron hull, floating bottom up?

CHALLENGER AND ARGUS BANKS, S.S.W. of Bermuda.

These off-lying banks, well known to the fishermen, are described previously, on pages 828—829.

Deep Soundings Southward of Bermuda. (Doubtful.)

In 1850, the commander of the ship *Chaucer* reported as follows:—"In lat. 27° 10′ N., long. 62° 45′ W. (which would be 330 miles *S. by E.* ¾ *E.*, true, from Bermuda), on April 20th, water blue, with much gulf-weed, weather calm, no current, the boat was lowered; let run the lead, and got bottom in 744 fathoms. April 15th, lat. 27° 31′ N., long. 60° 3′ W., sounded and got bottom in 366 fathoms. April 20th, lat. 29° 20′ N., long. 64° 11′ W., sounded and got bottom in 620 fathoms." There is no doubt but that the imperfect means employed deceived the commander as to finding bottom; for the U.S.S. *Dolphin* got a good sounding of 3,828 fathoms, the deepest obtained in the cruize, a degree to the South of that reported of 366 fathoms, and no bottom with 1,000 fathoms near that of 620 fathoms, and 3,080 fathoms has been found near that of 744 fathoms.

ECHO BANK, lat. 21° 12′ N., long. 58° 42′ W.

Lieut. A. H. Bisschop Greevelink, of the Dutch vessel *Echo*, a very reliable observer, reported as follows:—"On our passage from the West Indies to Europe, in July, 1887, at about 4 p.m. of the 7th, a serpentine streak, of a dark brown colour, was observed on the surface of the sea. Having lowered the boat, soundings were found to exist, although in more than 30 fathoms."

NICTHEROY BANK, lat. 5° N., long. 47° 5′ W.

In 1881, the captain of the *Nictheroy* reported that he found a depth of 52 fathoms, rocky bottom, in the above position, but a depth of 1,876 fathoms has been found a few miles to the eastward.

AYLEN OR PORGAS BANK, East of the Cape Verde Islands.

In the early charts of the Atlantic, this bank was shown as extending 150 miles in length, North and South, with a breadth of 15 miles. Nothing more than this appeared to be known of it, except that it was all deep water, and not dangerous to shipping. It was unsuccessfully sought for by the *Leven* in 1819, and in some later charts it was omitted for want of confirmation. However, the following is the report of a cast of the lead taken from the steamer *Birkenhead*, on her voyage to Ascension, under the command of Mr. J. B. Aylen, R.N., on November 11th, 1850. In lat. 17° N., long. 20° 3′ 15″, from careful and reliable observations, a depth of 86 fathoms was found; the bottom appeared to consist of pieces of shells and sand, or small particles of coral. Mr. Aylen says, "I did not like heaving the ship to, to take another cast, particularly as I considered myself on the edge of the bank only, and that at noon, when on its centre, I would again try, which I did without success with 90 fathoms of line."

Besides this sounding, another of 164 fathoms was obtained, in 1819, by Capt. Fréminville, to the N.W. of the above cast, in lat. 18° 35′, long. 21° 40′.

The following is an extract from a log examined at the Meteorological Office:—"Here is the position of Porgas Bank, according to the old charts; we sounded at noon in 17° 10′ N., 20° 32′ W., with 150 fathoms; got no bottom."

The following is from the log of H.M.S. *Hydra*. "August 1st, 1868. In lat. 16° 17′ N., long. 19° 43′ W., sounded on the eastern edge of the alleged Porgas Bank, obtaining 1,880 fathoms, oaze; noon, crossed the alleged position of Porgas Bank, no indication of shallow water. In 16° 46′ N., 19° 45′ W., sounded on a patch marked 86 fathoms *Birkenhead*, obtaining 1,850 fathoms, brown sand and mud." This latter sounding is about 20 miles S.E. of the position of the 86 fathoms sounding of the *Birkenhead*.

On May 10th, 1889, Capt. Russell, of the steamer *Dalton*, reported that from lat. 17° 55′ N., long. 24° 36′ W., to lat. 19° 30′ N., in the position ascribed to Porgas Bank, the colour of the water appeared to indicate depths less than 80 fathoms, and that he had observed the same appearance here for the past 8 years.

DORIC BANK, lat. 18° 57′ N., long. 18° 15′ W.

In 1890, a sounding of 56 fathoms was obtained from the telegraph steamer *Doric*, when about 100 miles westward of Cape Mirik; depths of 1,500 and 1,600 fathoms were found around it, at 17 miles distant. In 1891, the steamer *Silvertown* took four soundings in this locality, and found regular depths, 1,494, 1,497, 1,498, and 1,509 fathoms.

This concludes the description of isolated banks and shoals, which have been proved to exist, and of others about which there still remains some amount of uncertainty, and it is extremely probable that many of them do not exist. We now proceed, in the following Table (A), to give a list of the latter, and of those which are still more open to doubt. The particulars of each announcement are given in full in old editions of this work, but it is unnecessary to repeat them here.

The second list, Table B, shows those rocks, &c., which may be safely considered as absolutely disproved, and in most cases are not shown on the chart.

TABLE A.

ROCKS, ETC., WHOSE EXISTENCE IS VERY DOUBTFUL.

Name.	Reported by	Date.	Lat. N.		Long. W.		Particulars.
			°	′	°	′	
Amplimont Rocks	Guichardi .	1735	42	30	24	5	About 30 ft. high.
" "	Mills.........	1829	42	30	24	5	About 30 ft. high.
" "	Alderson ...	1842	42	51	24	15	8 or 10 ft. high.
" "	Duff	1846	42	56	24	30	Awash.
Birkenhead, 86 fms.	Aylen	1850	17	0	20	3	On Porgas Bank.
Chantereau Shoal	Chantereau	1721	38	24	41	35	
" "	Scott.........	1828	38	16	38	49	Princess Elisabeth Shoal.
" "	Perez	1846	38	27	37	57	
Columbine Shoal...	Robertson..	1844	35	25	49	1	Discoloured water.
Constante Reef ...	Ferreira ...	1840	37	56	33	4	
" "	Keyzer	1845	37	42	32	57	A white patch.
" Açores Rf.	Van Keulen	1742	37	50	34	18	Or Martyr Reef.
Dædalus Rock......	Taylor	1813	....		....		35′ to 45′ S.W. of C. St. Vincent.
" "	Stokes	1821	....		....		28′ to 30′ N.N.E. " "
" "	Aves	1839	36	30	9	16	Position doubtful.
Delaware Shoal ...	Ross	1839	10	37	60	8	Five fathoms.
Devil Rocks.........	Brignon ...	1737	46	55	13	0	Level with the surface.
" "	Thomas ...	1764	46	24	13	10	Three feet above water.
" "	Peter	1818	46	35	13	7	Two feet water over it.
" "	Henderson.	1829	46	33	13	2	Two feet above water.
" "	Livingston.	1826	46	9	12	50	Level with the surface.
" "	Swainson...	1829	46	35	13	8	High breakers.
Dvina Rock	Grote	1853	44	45	9	37	Level with surface; breakers.
Ferreira Reef	Ferreira ...	1840	38	27	30	25	Awash.
Gough Rocks	Gough	1778	40	28	30	0	Above water.
" "	Beaufort ...	1820	40	33	30	0	Twelve and 8 ft. above water.
" "	Robertson .	1862	40	38	30	8	Just awash.
Harrison Rocks ...	Harrison ...	1830	40	16	33	0	Level with the surface.
Hilton Rocks	Hilton	1845	39	18	35	50	Nearly awash.
Keus or Europa Rk.	Keus.........	1853	38	15	22	14	A black mass, 15 or 20 ft. high.
Kutusoff Bank......	Espiñosa ...	1816	35	0	28	30	Perhaps St. Mary Bank.
Laura Ethel Bank.	*Laura Ethel.*	1878	46	55	38	50	A cast of 36 fms., sandy bottom.
Mossman Rock ...	Mossman...	1854	43	41	28	51	A few feet above water.
Midgley Shoal......	Midgley ...	1838	44	10	22	58	Discoloured water. Not sounded.
Munn Reef	Munn	1827	39	0	64	20	White sandy bank above water. Position undetermined.
Neva Rocks	....	1856	31	10	34	40	Four feet above water.
Romantico Rock...	B. *Romantico*	1886	31	43	33	43	Of a red colour, 4¾ ft. high.
Ryder Shoal.........	Ryder	1845	46	30	49	41	Very doubtful.
St. Mary Bank......	Livingston.	1819	35	53	27	19	White water.
Watson Rock	Watson ...	1824	40	18	53	40	Awash; prob. ice. *See* Daraith and Hamilton, in Table B.
Westenenk Shoal...	Westenenk.	1840	31	48	40	28	Breakers.

TABLE B.

ROCKS, ETC., REPORTED, BUT DO NOT EXIST.

Name.	Reported by	Date.	Lat. N.	Long. W.	Particulars.
			° ′	° ′	
Aitkin Rock.........	Aitkin	1740	55 18	11 14	About 4 ft. water over it.
„ „	*Nestor*	1793	55 19	9 53	„ „ „
„ „	....	......	55 15	10 40	Three feet above water.
„ „	Reid.........	1826	55 17	......	A little above the surface.
„ „	Craig	1852	55 15	9 56	
Akett..................	....	......	......	......	*See* Daraith.
Alof Kramer Bk....	Kramer ...	1751	60 57	16 40	No particulars.
America Rock......	Sh. *America*	1846	40 20	63 50	From 25 to 30 ft. high; probably a wreck.
Anna Rock	Carmelich .	1841	39 32	50 50	About 50 ft. high; probably ice.
Anfitrite Shoal......	*Anfitrite* ...	1846	35 50	66 4	A patch of breakers.
Ashton Rock.........	Guy	1824	33 49	71 41	Conical rock, about 8 ft. high.
Atila Rock	Ship *Atila*...	1856	36 31	32 24	Sunken.
Aylen Bank	....	......	......	......	*See* Porgas Bank.
Barencthy Rock ...	....	1726	45 33	37 25	
Beazley Shoal......	Beazley ...	1841	40 45	36 47	Almost awash.
„ „	Span. Ship .	1769	40 26	36 5	Five fathoms over it.
„ „	Wahlstein .	1857	40 26	36 13	Sudden breakers; discol. water.
Bell Rocks	Bell	......	33 45	55 25	
Betsey Rock.........	....	1808	18 7	50 0	A flat rock.
Blaesdale Reef......	Blaesdale...	1819	0 57	41 22	Brig *Richard* struck, and remained fast 10 minutes.
Bom Felix Shoal...	Dultra	......	19 20	20 37	Sounded in 4 fathoms.
Bonetta Rocks......	....	......	......	......	*See* Emily Rocks.
Bordelaise Rock ...	....	1832	30 25	27 25	Two rocks just above water.
Bouvet's Sandy Id.	Vaillant ...	1761	0 20 S.	19 5	A little sandy island.
Brasil Rock	Brouage & Laisne ...	1742	51 0	17 10	
„ „	....	1791	51 0	16 0	A high rock or islet.
Breton Rock	Breton	......	39 40	41 35	
„ „	Ship *Tiger*..	1816	39 40	41 40	Agitated sea, and field of weed.
Bus, Sunken Ld. of	....	......	58 0	33 0	
Cæsar Breakers ...	....	1730	2 0	22 18	
Candler Rock	Candler ...	......	39 47	34 29	About 100 ft. high; probably ice.
Chaderton Reef ...	Chaderton .	1858	44 56	23 51	Awash.
Chapolle Rock... ..	Houel	1764	47 24	7 12	
„ „	*Favorite* ...	1822	47 37	8 2	Discoloured water.
„ „	Tasker	1842	47 43	8 5	About 4 ft. below the surface.
„ „	Vaillant ...	1857	47 30	8 5	About 2 or 3 ft. below surface.
Chaucer Bank......	Henderson .	1850	42 45	28 48	Hard bottom at 48 fathoms.
„ „	*Chaucer*......	1850	27 31	60 3	Sounded in 366 fathoms.
Clark Rock	....	......	......	......	*See* Mayda Rock.
Cleveland Reef......	Cleveland ..	1765	30 45	10 20	
Clowes Reef	....	1817	19 17	65 50	Very little water on it.
Coral Shoal	....	1822	0 30	29 35	
Corsair	....	......	......	......	*See* Daraith.
Courier Rock	Thompson .	1849	27 51	78 31	Prob. struck on Matanilla Reef.
Daraith Island ...	Daraith ...	1700	40 50	54 53	Probably ice. *See* Hamilton and Watson.
Dario Rock	Brig *Dario* .	1834	37 12	9 31	Seen by the captain.
Desmaires Rock ...	Desmaires .	1683	42 0	41 10	*See* Druid Reef; perhaps ice.
Druid Reef	Treadwell .	1831	41 19	41 25	About 3 ft. high; perhaps ice.
„ „	Spanish Ch.	1803	41 24	41 20	„ „ „ „
Dubreuil's Vigia ...	Dubreuil ...	1753	14 50	29 40	*See* Tregarthen & India Shoals.
Dyet Rocks	Dyet.........	1845	32 46	60 6	Two rocks, 6 or 8 ft. over them.
Eight Stones	Vobonne ...	1732	34 37	16 40	Perhaps disappeared.
Emily Rocks	Ship *Emily*.	1845	16 32	20 37	Or Bonetta Rocks.

Name.	Reported by	Date.	Lat. N.		Long. W.		Particulars.
			°	'	°	'	
England Rock......	....	......	......		......		*See* Mayda Rock.
Esmeralda Rock...	*Esmeralda*...	1856	45	13	16	48	About 4 ft. above the water.
Esperance Rocks...	Duff	1846	42	56	24	30	Two pointed rocks, awash. (*See* Morning Star Rocks.)
Falconer Rock......	Falconer ...	1847	38	40	29	8	
False Bermudas ...	Duhal	......	32	10	58	10	A rocky shelf, awash.
Field's Vigia	Field.........	1833	37	31	66	0	Probably floating weed.
Five Heads	Van Keulen	1757	44	15	19	25	Rocky shoal, part above water.
Fonseca Island ...	....	......	......		......		*See* Galissionière Rock.
French Shoal	Spanish Ch.	1796	4	5	20	35	Even with the surface.
,, ,,	French Ch.	......	4	15	19	20	
,, ,,	Log, Met. O.	......	4	4	22	25	
Galissionière Rock	Galissionière	......	12	20	54	49	Perhaps volcanic.
Galleon Bank	Longueville	1730	15	56	49	40	Ships struck; prob. volc. shock.
Gandaria Rocks ...	Gandaria...	1842	25	30	37	45	One large and high.
Garças, Baxo das .	Dutch Cht.	......	13	0	29	50	
,, ,,	Lo. e Pinho	1818	12	30	28	56	Breakers and a shoal.
Garcia Guerra Rk.	G. Guerra..	1837	36	36	10	51	*Pelicano* touched on a white rk.
Gilchrist Rock......	Gilchrist ...	1848	32	0	24	48	A flat rk. awash. *See* Josyna Rk.
Gombaud Rock ...	Gombaud ..	1764	23	15	32	25	
Green Rk., I. Verte	Le Boccage	1742	44	52	26	25	Stated later to be 20 ft. high.
Greeve Ledge	Greeve	1745	44	15	25	5	Nearly level with the surface.
Guigou Bank	Guigou......	1688	......		......		A rocky bank, with sandy islet.
,, ,,	Whipple ...	1733	20	50	66	45	
Hamilton Rock ...	Hamilton...	1851	40	25	54	28	Probably ice.
Hannah Breakers .	....	1791	20	0	63	50	
Hannah's Coral Sh.	Fanning ...	1824	10	7	27	32	Sounded in 15 fms.; weeds seen.
Henderson B., 48 fs.	Henderson.	1850	42	45	29	0	Discoloured water, and ripple.
Hervagault Brkers.	Hervagault	1723	41	2	49	23	Two rocks; probably ice.
,, ,,	Maxwell ...	1823	41	2	49	23	Three breaking rocks.
,, ,,	Lourp	1816	41	6	49	57	
,, ,,	Marquand..	1855	40	27	49	56	About 3 ft. high.
Huntley Rock......	Huntley ...	1833	30	49	78	27	A coral rock, 8 ft. high.
India Shoal	E. I. Ships.	......	15	45	27	20	*See* Tregarthen Rock.
Inglefield Bank ...	Inglefield...	1810	29	42	80	17	Sounded in 24 fms., sand & shells.
Jaquet Island	Le Gros ...	1836	46	55	39	30	Probably an iceberg.
Jean Hamon Rock.	Hamon ...	1733	36	54	19	49	
Job Rock	Job	1858	46	25	35	40	Three breaking heads; prob. ice.
Josyna Rock.........	*Josyna* lost .	1697	31	40	23	45	*See* Gilchrist Rock.
Laidman Rock......	Laidman ...	......	46	0	26	0	Probably a volcanic shock.
Lean Shoal	Lean.........	1854	45	32	11	57	Heavy breakers.
Longchamps Rock	Dutch Cht.	......	9	47	30	0	Or Solis Island.
Lourp	....	......	......		......		*See* Hervagault Breakers.
Maalstrom	Van Keulen	......	16	0	37	0	
Maria Rock	Sch. *Maria*.	1813	19	45	20	50	Struck, and lost her rudder.
Marinero Rock......	Swinton ...	1831	46	0	30	0	1,760 fathoms near.
Marquand	....	......	......		......		*See* Hervagault.
Martin Reef.........	Bellin	1742	16	42	58	53	
,, ,,	Martin ...	1816	......		......		Shoal of yellow sand, with weed.
,, ,,	Ship *Cecilia*.	1823	16	44	58	50	About 2 miles long, 30 ft. wide.
,, ,,	Newbold ...	1842	16	42	59	6	A small shoal.
Morning Star Rks.	Alderson ...	1842	42	51	24	15	Two rks. awash, 8 or 10 ft. apart.
Mourand Bank ...	Mourand ...	1773	24	34	65	10	Bank of red sand, partly dry.
Mayda (Five Hds.)	P. Nau......	1705	46	48	19	50	A little white island.
,, ,,	Biden	1738	46	10	19	40	Five heads of rks., and breakers.
,, ,,	Clark	1842	45	40	19	17	Two-headed rock, uncov. 6 or 8 ft.
,, ,,	England ...	1840	46	36	19	30	Conical rock, awash.
Negre Rocks.........	Negre	1722	48	8	20	30	
,, ,,	Bauve	......	48	7	21	21	
Orion Rock	Luytjas ...	1845	34	51	72	28	Like a cask, 2 ft. above water.
Patty Overfalls ...	Patty	1820	11	0	24	30	
Perseus Shoal	Ship *Perseus*	1813	41	3	22	30	
Porgas Bank	Old Charts.	......	16	17	19	43	Deep soundings; see page 897.
Potomac Soundgs.	Smith	1838	38	10	67	26	A depth of 90 fathoms.
Prince Shoal	Thomas ...	1853	0	54	26	50	Volcanic shock.

Name.	Reported by	Date.	Lat. N.	Long. W.	Particulars.
			° ′	° ′	
Pronk or Rhoon Rks.	Pronk	1844	38 32	33 16	Pinnacle rocks, 16 ft. high.
Pryce Shoal	Pryce	1846	3 7	24 14	Breakers. *See* Cæsar Breakers.
Ramigeau's Vigia..	....	1750	42 42	37 30	
Reguera1 Shoal ...	A. Regueral	1798	36 35	11 3	Sounded in 64 fathoms, shells. Probably Gettysburg Bank.
Rocks	....	1876	38 5	37 23	Two rks.; not seen here in 1892.
Roallon Rocks......	....	......	......	......	*See* Three Chimnies.
St. Esprit Reef ...	*St. Esprit*...	1817	14 37	58 59	Chain of rocks, 8 ft. under water.
,, ,,	Ld. W. Paget	1833	......	......	Sounded in 7 fms.; perhaps volc.
Smith or Wallace R.	Smith	1856	49 37	16 17	About 6 or 8 ft. water over it.
Spanish Shoal	....	......	......	......	*See* Beazley Shoal.
,, ,,	Span. Chrt.	1798	40 22	42 40	
Sprigg Rock	Sprigg	1842	46 12	15 3½	
Steen Ground	Bellin, &c. .	......	32 20	20 50	A sandy islet, 1½ mile long.
Texeiro Shoal	Texeiro......	1810	12 0	33 28	Breakers.
Three Chimnies ...	De C. Fernel	1729	47 54	29 40	Probably ice.
,, ,,	Roallons ...	1842	47 37	28 51	
Tregarthen Rock...	Tregarthen.	1856	14 29	26 30	Four feet high. *See* Dubreuil's Vigia and India Shoal.
Tulloch Rocks	Tulloch ...	1808	37 27	24 45	Volcanic; disappeared.
Tulloch Overfalls ..	Tulloch ...	1819	24 11	61 44	No danger seen.
Ugarte Shoal	Ugarte	1832	36 38	11 22	Sounded 3 fms. sand; breakers.
Verte Isle	....	......	......	......	*See* Green Rock.
Vigia	....	......	37 50	34 18	
,, ...	Surgeac ...	1750	40 53	52 0	Probably ice.
,, ...	Span. Chrt.	1798	43 30	37 35	Probably ice.
,, ...	French Cht.	1746	55 24	24 40	Rock, high above water.
Vigia de Cinco Palmas	....	......	12 0	27 20	Or Hinman Shoal.
Wahlstein Brkers.	Wahlstein .	1857	40 26	36 13	*See* Beazley Shoal.
Walker Shoal	Maury's Ch.	......	4 14	27 36	
Warley Shoal	Ship *Warley*	1813	5 4	21 25	Rocky bottom seen; 7 fathoms.
Whale Rock.........	Gradun ...	1800	38 46	24 47	
Woodall Rock	Woodall ...	1829	43 20	25 10	Conical rock, awash.

We have thus concluded the catalogue of dangers, and presumed dangers, which for so many years "disfigured our charts." As will be seen by reference to the charts, the direct test of the sounding lead has caused the disappearance of most of them; and they are mainly retained here as an interesting record.

2.—VOLCANIC REGIONS.

In the neighbourhood of the Equator, and between longitude 16° and 24° W., is an area which in former years was very fertile in the production of supposed rocks and banks. The nature of this area is now better understood, and we have thus only the occasional announcement of volcanic shocks having been felt. They are indeed very numerous, and in our South Atlantic Directory, we have given a series of these occurrences. They need not, therefore, be repeated here.

It is now well known that an earthquake or *tremora* at sea has exactly the same effect on vessels as if they had rubbed over a reef of rocks, or the heavy cable had suddenly run out. We have many instances of this, and such effects may be looked for in crossing the Equator within these limits. It may perhaps extend as far to the West as the volcanic islets of Peñedo de San Pedro. The region between these islets and the Windward Islands is also much subject to earthquakes. In September, October, and November, 1890, numerous shocks were reported from this area.

To the list mentione on the previous page, we may add, by way of example, the following here:—

Captain Ballaird, of the ship *Rambler*, on October 30th, 1850, in lat. 16° 30′ N., long. 54° 30′ W., and Captain Potter, of the barque *Millwood*, half an hour later on the same day, when in lat. 23° 30′ N., long. 58° W., each felt a volcanic shock. These vessels were about 520 miles apart; supposing them to be in the direct line in which the earthquake was travelling, its rate will appear to be about 1 mile in 5 seconds, which is only a little slower than sound travels through the air.

The U.S. sloop *Vandalia*, December 15th, 1859, near midnight, in lat. 17° 34′ N., long. 55° 49′ W., experienced the shock of an earthquake, which lasted 5 seconds, and was accompanied by a low rumbling noise, and strong vibration throughout the ship. The wind, which was N.E., immediately veered to East, and decreased.

The Russian ship *Dallas*, W. Wikander, commander, on March 20th, 1861, at 7 p.m., lat. 0° 27′ N., long. 20° 30′ W., apparently went over the ground; the masts and yards were shaken, and they found afterwards that the false keel had gone. At the same moment another ship, the *Melbourne*, C. Cowie, master, in lat. 0° 20′ N., long. 20° 35′ W. (that is, 8½ miles distant from the Russian ship), was startled by hearing a loud rumbling noise, and at the same time felt the ship tremble from stem to stern, which lasted 4 or 5 minutes.

The ship *Florence Nightingale*, January 25th, 1859 (1 p.m.), having St. Paul Rocks bearing N.W. by N., distant 10 miles, experienced a severe shock. The captain states:—"It commenced with a rumbling noise like distant thunder, and lasted about 40 seconds. During the first part (? of the day), there was a small confused sea, but after the earthquake a heavy swell from N.N.E. I am perfectly familiar with earthquakes, having experienced many on the West coast of America, but I never felt one so severe as this. Glasses and plates on the table jingled to a great extent; articles were shaken off the after-hatch, and the ship felt as if grinding heavily on a reef, which idea found general belief, for the cry of 'The ship's ashore!' burst simultaneously from the lips of all on board, and the watch below came tumbling up in great haste. I was very much startled, and ran to the side to look for bottom, but soon remembered what it was, and allayed the panic by explaining that it was only an earthquake."

The following must refer to the same shock, as it occurred within half an hour of the time of the preceding. The captain of a vessel states, in his log, that at 0h 30m p.m., January 25th, 1859, in about lat. 0° 6′ N., long. 30° 28′ W., or about 84 miles N.E. by E., from the position of the *Florence Nightingale*, he "experienced a shock on board, the vessel trembling and heeling over, the sensation being something similar to that of a vessel dragging her anchor in a tideway. The shock lasted about

1¼ minute; it was evidently the effect of some volcanic agency, and was so distinctly felt as to alarm all hands. There was nothing peculiar in the appearance of sea or air. The weather was squally, with showers."

Captain Whitmore, of the *Sea Serpent*, December 29th, 1859, struck, as he supposed, on a coral reef, in lat. 0° 29′ N., long. 28° 30′ W., in consequence of which he put into Rio. He sounded immediately, and found no bottom, but afterwards found his false keel and copper injured.

The Russian sloop of war *Passodnik* struck, as was supposed, on the same shoal, about twenty-four hours before the *Sea Serpent*, but this proves the nature of the occurrence.

The *Prince*, James Thomas, commander, December 11th, 1853, in lat. 0° 54′ N., long. 26° 50′ W., smooth water, suddenly felt a grinding tremor go through the vessel, as if dragging over something rough and yielding. It continued for about the ship's length, but did not stop her way through the water. The ship did not strike.

The ship *Maid of Judah* felt a slight shock September 15th, 1855, in lat. 1° 30′ N., long. 25½° W. Strong swell from the southward.

On the night of July 1st, 1886, Capt. Rood, of the barque *Antwerp*, felt a shock on or near the Equator, in long. 26° 55′ W.

On November 16th, 1886, Capt. Wakeman, of the barque *Bankfields*, in lat. 0° 50′ N., long. 29° 54′ W., felt two severe shocks of 16 to 20 seconds, separated by an interval of 20 minutes. The vessel trembled greatly, and a rumbling noise was heard, as though dragging over shingle. The sky was clear, and the weather fine but sultry, with a high confused sea.

The barque *Eleanor*, Captain G. A. Findlay, March 26th, 1861, at 10 a.m., felt a shock as if something very heavy was being rolled about the decks, or as if the ship had gone over some rough ground; it made the vessel tremble only for a few seconds. A rumbling noise was heard, like distant heavy thunder. Weather remarkably fine; lat. 0° 44′ N., long. 21° 19′ W. Great quantities of fish and sharks around the ship.

These instances, with the others, will afford ample evidence of the general nature and locality of these volcanic shocks. We have limited the instances above given to this particular area on the Equator; but there appears to be either an extension of this action far to the northward, or else there is a separate area, for volcanic shocks have been felt as far North as 23° 30′ N., and long. 58° 0′ W.; and from the almost continuous line of discoloured and peculiar water that extends from the Equator to this position, as will be presently stated, we are led to infer that there is a line of volcanic action trending parallel to the range of the Antilles.

The depth, however, is very great, and there is now not any reason for supposing that any shoal exists. Lieutenant Lee and others have found depths exceeding 2,000 fathoms over most of the region in question; and this is another evidence of the wonderful force of these shocks, which can be transmitted through a stratum of water 12,000 feet and upwards in thickness.

We now proceed to give a few reports of shocks experienced in other regions of the North Atlantic, many of them taken from records on the U.S. Pilot Chart of the North Atlantic Ocean.

and such effects may be looked for in crossing the Equator within these limits. It may perhaps extend as far to the West as the volcanic islets of Peñedo de San Pedro. The region between these islets and the Windward Islands is also much subject to earthquakes. In September, October, and November, 1890, numerous shocks were reported from this area.

To the list mentione on the previous page, we may add, by way of example, the following here:—

Captain Ballaird, of the ship *Rambler*, on October 30th, 1850, in lat. 16° 30′ N., long. 54° 30′ W., and Captain Potter, of the barque *Millwood*, half an hour later on the same day, when in lat. 23° 30′ N., long. 58° W., each felt a volcanic shock. These vessels were about 520 miles apart; supposing them to be in the direct line in which the earthquake was travelling, its rate will appear to be about 1 mile in 5 seconds, which is only a little slower than sound travels through the air.

The U.S. sloop *Vandalia*, December 15th, 1859, near midnight, in lat. 17° 34′ N., long. 55° 49′ W., experienced the shock of an earthquake, which lasted 5 seconds, and was accompanied by a low rumbling noise, and strong vibration throughout the ship. The wind, which was N.E., immediately veered to East, and decreased.

The Russian ship *Dallas*, W. Wikander, commander, on March 20th, 1861, at 7 p.m., lat. 0° 27′ N., long. 20° 30′ W., apparently went over the ground; the masts and yards were shaken, and they found afterwards that the false keel had gone. At the same moment another ship, the *Melbourne*, C. Cowie, master, in lat. 0° 20′ N., long. 20° 35′ W. (that is, 8½ miles distant from the Russian ship), was startled by hearing a loud rumbling noise, and at the same time felt the ship tremble from stem to stern, which lasted 4 or 5 minutes.

The ship *Florence Nightingale*, January 25th, 1859 (1 p.m.), having St. Paul Rocks bearing N.W. by N., distant 10 miles, experienced a severe shock. The captain states :—"It commenced with a rumbling noise like distant thunder, and lasted about 40 seconds. During the first part [illegible] the day), there was a small confused sea, but after the earthquake a heavy swell from N.N.E. I am perfectly familiar with earthquakes, having experienced many on the West coast of America, but I never felt one so severe as this. Glasses and plates on the table jingled to a great [illegible] articles were shaken off the after-hatch, and the ship felt as if grinding heavily on a reef, which idea found general belief, for the cry of [illegible] ship's ashore!' burst simultaneously from the lips of all on [illegible] watch below came tumbling up in great haste. I was [illegible] and ran to the side to look for bottom, but soon [illegible] and allayed the panic by explaining that [illegible]

The following must refer to the [illegible] an hour of the time of the [illegible] his log, that at 0ʰ 30ᵐ [illegible] long. 30° 28′ W., or [illegible] *Florence Nightin*[illegible] trembling and [illegible] of a vess[illegible]

[illegible]

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Evans.

The whaler *Sheffield*, Captain Green, April 26th, 1859, in lat. 29° 55′ N., long. 60° 10′ W., experienced three severe shocks of earthquake, between 4^h 25^m and 6^h 10^m a.m. The officer on duty reported that the sea for some time previously had presented the appearance of a tide-rip; the noise might be compared to that of a heavily loaded cart or waggon, drawn rapidly over a plank road.

On December 2nd, 1882, at 6.30 p.m., a heavy shock was felt on board the barque *Aneroid*, of Swansea, then homeward bound with a cargo of copper-ore. The position given was lat. 24° 29′ N., long. 64° 38′ W., nearly midway between Porto Rico and Bermuda, and according to the *Challenger* soundings hereabout the depth would be nearly 3,000 fathoms.

On March 13th, 1891, between 7 and 8 p.m., Capt. Petersen, of the barque *Eleanora*, experienced a submarine disturbance in the volcanic region West of St. Paul Rocks, in lat. 3° 47′ N., long. 42° 3′ W. The vessel was heading N.W., going about 3 knots, when a noise was heard like a heavy surf, and the sea began to bubble and boil, the broken water reaching as high as the poop deck. It lasted about an hour, but no distinct shock was felt. It then ceased for an hour, when a similar disturbance again ensued.

On November 20th, 1890, in lat. 8° 45′ N., long. 40° 28′ W., Capt. Crosbie, of the barque *P. J. Carleton*, reported that the sea became like a boiling pot, tumbling about in a seething mass, and greatly confused. A grating sensation was felt, as though going over a reef.

On April 1st, 1887, Capt. Lassan, of the Norwegian barque *Petty*, in lat. 17° 38′ N., long. 46° 34′ W., felt three distinct shocks, accompanied by an eruption of gas bubbles, covering the surface.

On January 24th, 1887, Capt. Erskine, of the barque *St. Lucie*, in lat. 27° 39′ N., long. 43° 54′ W., felt three distinct shocks of about 5 seconds each, shaking his vessel severely.

On August 23rd, 1891, at 10.30 a.m., in lat. 36° 44′ N., long. 59° 47′ W., Capt. Hughson, of the steamer *Robert Harrowing*, reports that the sea became strangely and unusually disturbed, the commotion increasing until the decks were filled with water. At 1 p.m. the sea suddenly became calm.

On November 5th, 1886, when in 13 fathoms, southward of Charleston, the captain of the barque *Amelia Camp* felt an earthquake shock. And on the same day, in lat. 32° 50′ N., long. 78° 23′ W., Capt. Cates, of the brig *Arcot*, experienced a very heavy shock, lasting about 12 seconds, shaking the vessel as if dragging over rocky bottom. There was nothing unusual noticeable in the motion of the sea.

On September 23rd, 1887, between 7 and 8.45 a.m., several shocks were experienced by three vessels off the S.E. end of Cuba, in an area about 250 miles in diameter, shaking them as though they had touched the ground. Capt. Armstrong, of the steamer *Alps*, felt the first shock in lat. 19° 44′ N., long. 74° 24′ W.; it lasted about 45 seconds. The sea was smooth, but appeared to rise in a solid body without the least break. The other two vessels were off the northern side of the S.E. end of Cuba.

3.—DISCOLOURED WATER.

In various parts of the Ocean, particularly in the Equatorial and Tropical regions, patches of discoloured water are occasionally met with, which at times may appear like shoal water, and are due to various causes. In the open sea, they may be owing to the minute spores of marine plants, or to the presence of minute animal life, in prodigious abundance; in the volcanic regions, it is conceivable that they may be due to submarine disturbances; and near the coasts, they may consist of matter discharged by large rivers, and this is notably the case off the mouths of the Orinoco and Amazon. We now proceed to give a few details of some of these appearances.

At 3 p.m., July 15th, 1792, Don Cosme de Churruca, then on his passage to the West Indies, discovered a boiling and breaking of the sea, so very extraordinary, that it appeared to be breakers; but found no bottom at 150 fathoms. This phenomenon appeared to be in consequence of a current setting against the wind. On the 16th, at 10 a.m., they were in lat. 13° 56′, long. 54° 7′ W., nearly 400 miles to the eastward of St. Lucia, and 450 miles to the N.E. of the Orinoco, and observed that the colour of the water changed, looking like muddy river water, or as if they were on a bank. They continued their course without alteration; sounded at night, and found no bottom at 120 fathoms. Churruca says that the colour is always the same in that part of the ocean, always appearing as if on soundings in that region, and that it never varies the position of its limits. In addition to his own remarks, he had assured himself of the fact by information collected from various sources; such as the English Sailing Directions for the year 1782, entitled the "Complete Pilot for the Leeward Islands," which, in the account of Barbados, mentions that this phenomenon is found at the distance of 210 to 240 miles to the eastward of that island, and that there are no soundings, though the water seems as if there were.*

The passage, from the above Directions, is as follows:—"In the latitude of Barbados, about 70 or 80 leagues to the eastward, you will find the water discoloured and prodigiously thick, as if there were soundings, but there are none, and you may depend on being at the distance aforesaid from the island."†

Lieut. Greevelink, in alluding to Mr. Luccock's and Captain Kotzebue's remarks about patches of water exhibiting a brown and dirty appearance, says:—"I should question with all deference, whether the depth of water in such places was tried to a sufficient degree of certainty. On our passage from the West Indies to Europe in July, 1837, at about 4 p.m. of the 7th, a streak was observed on the surface of the sea, exactly in the same manner as Captain Kotzebue describes, and at the moment we passed over it the lead was hove in a very proper manner without finding bottom; but, having lowered the boat, soundings were found to exist, although in more than 30 fathoms of water. The latitude was 21° 12′ N., long. 58° 12′ W." Lieut. Lee found 2,800 fathoms here.

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* Captain Livingston remarks:—"It seems that the appearance of soundings, described above, occurs in the same place where Captain Tulloch told me a bank existed, which some Americans were in the habit of making as a fresh point of departure when bound to Surinam, &c." But Lieut. Lee, in the *Dolphin*, found depths of 2,500 fathoms here.

† "In 1813, at 197 miles to the eastward of Barbados, we found the water discoloured; the thermometer here rose 1°. The current (Equatorial) inclines to the northward here; which, as well as the discoloured water, may be attributed to the stream discharged by the great River Orinoco, &c."—*Lieut. Evans.*

Off the coast of Guayana, at about 7 a.m., September 17th, 1835, on the track of the *Echo* from Antigua towards Surinam, there appeared in every direction, upon the surface of the ocean, several large spots of discoloured water, more or less thickly mingled as it seemed with mud. It was a fine morning; the sun rose in all its splendour, and not a single cloud was there to throw its shade upon the water, which was uncommonly smooth, although the ship ran 6 miles an hour; besides the water in some of the spots was so thick as to make the blue waves curl against their edges. "Having," says M. Groevelink, "the watch at the time, I gave warning of this strange occurrence to our captain (W. H. van Voss), who came on deck and ordered me to keep—not to alter—our course, by which we passed through one of those spots, yet we did not heave the lead, as it was the first day in which we gained a breeze after fourteen days struggling with horrible calm and rainy weather, and two-thirds of our crew confined to their hammocks. While in the midst of these spots, I observed the latitude to be 11° 47′ N., and the longitude 53° 47′ W. In about three-quarters of an hour we were clear of them, and the sea resumed its former clearness. The current, Equatorial, for several days remained northerly, yet was not very strong." Lieut. Lee found no bottom here at 2,780 fathoms.

"That we had not been in soundings, we felt nearly convinced by existing circumstances; yet how came this muddy water here? The common discoloured water of Barbados it was not, as the latter is a large extent of water, of a different but somewhat lighter hue than that of the ocean; at least so far as we have seen it. As for my humble opinion, I seek for a cause of this appearance only in the force with which the Marañon rushes downward, but without sufficient power to strengthen the Equatorial Current. This may seem contradictory, but I think it may be found reconcileable in the manner following:—

"This river impetuously pours forth its waters in a mass over a bed of some declivity, which steepens more and more towards its issue till it becomes a precipice, so as to form a cataract, whereby a part of its stream may dive beneath the stratum of undulations of the ocean, and afterward rise to the surface by its lesser specific gravity; where, driven still farther off by the northerly current, it may easily remain for some days in the above-mentioned manner, especially in those months wherein continual calms prevail, and the water is rarely disturbed by the wind." This may be the case, but it may also be attributed to a volcanic origin.

The commander of H.M. (Netherlands) brig *Koerier* informed Captain Stort, that in the month of May, 1854, when between lat. 16° and 17° N., and in long. 54° W., he sailed for a whole day in dark-coloured water. This was particularly remarked, inasmuch as similarly coloured sea is met with in about lat. 10° and more easterly.* White-coloured water has also been observed in lat. 16° N.

Captain Nockells, in the ship *Brightman*, of London, May 5th, 1835, observing that the sea appeared of a dirty dark green, in lat. 41° N., long. 13° 19′ W., tried for soundings, but found no bottom at 240 fathoms. In two previous voyages, he found the water in the same place very much discoloured, which he supposed might originate from the melting of the ice in the northern latitudes.

A remarkable change in the colour of the sea was observed by M. Dupetit Thouars, on board the French frigate *La Vénus*, in lat. 21° 50′ N., long. 19° 34′ W., in the same spot which Fraisier had already pointed out. The officers thought it was a bank, but no bottom was found with 550 fathoms.†

With the announcements before given, of *Betsy Rock*, *Galissionière Rock*, *Martin Reef*, *St. Esprit Reef*, and the singular phenomena related by Churruca, Greevelink, and Nockells, it may be inferred that a large extent of ocean, running parallel with the range of the Windward Islands, covers either a range of submarine volcanoes, or that the bed is in a state of action from the same cause.

Lieut. Lee, in the U.S. brig *Dolphin*, also met with discoloured water in lat. 12° 22′ N., long. 54° to 55° W., but found no bottom at the East end of this with 1,000 fathoms, and a depth of 2,570 fathoms at its West end. He again came into discoloured water in lat. 14° 10′ to 14° 50′ N., long. 54° 30′ to 55° 0′ W.

On November 10th, 1884, Captain J. C. Martin, SS. *Bellarena*, wrote to us as follows:—"On October 1st, 1884, weather calm, and sea very smooth, in lat. 9° 30′ N., long. 55° 30′ W., whilst on a voyage to Demerara from Glasgow, I saw what I at first thought large patches of weed, similar to Gulf weed, at some distance on our beam; shortly after, we passed through beds of it, and it appeared when close like liquid palm-oil, and floating as such; the water under the scum was a beautiful blue; we steamed through alternate beds for upwards of 30 miles. I threw a bucket in passing and caught some, which I bottled, and now send you; it appears to me nothing but immense beds of spawn, and I should think, with wind and sea, would not be perceived." On examining this with a powerful microscope, it was seen to be of vegetable origin, appearing like wisps of grass, jointed similar to the bamboo, but much closer, probably the spores of some marine plant. The locality is considerably to the South of the region described above.

In the region between lat. 20° N. and 10° S., between long. 10° and 40° W., for which numerous logs were examined by the Meteorological Office, in acquiring a knowledge of the Best Route across the Equator, the following notes occur on the subject now under consideration. It may be remarked that the logs were chiefly collected by the late Admiral FitzRoy, between the years 1855 and 1870.

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* "Verhandelingen en Berigten," 1854, page 385.

† "Voyage de la Vénus," vol. iii., page 446.

Between 10° and 20° N. (Squares 38, 39, 40, see diagram, page 481).—*June.*—In 17° 30′ N., 25° 30′ W., N.W. of Cape Verdes, "Passed through several streams of small particles of a *deep red colour*, apparently whale food."

September.—In 16° N., 21° W., 100 miles East of Cape Verde Islands (1865), "A long, continuous *straw-coloured streak* of matter in the water. When seen under the microscope, it looked like bundles of fibres stuck together with some glutinous matter, which released its hold after they had been kept some time in a tumbler, and allowed the fibres to fall apart." Another remarks (1856), 10° N., 27° W., "*Much yellow matter* on the surface of the water, parts of which, when seen through the microscope, looked like longitudinal cells or tubes of vegetable matter placed side by side, as in the Pandean Pipes. They were transparent, and rounded off at their ends."

October (1870).—In 12° N., 26° W., "Sea covered with stuff looking like *Cowhage*. When viewed through a magnifying glass it appeared very much like a fid, shary-pointed at one end, rounded off at the butt, and of various sizes, the largest about 1-16th of an inch."

December.—(1851). In 19° 57′ N., 19° 19′ W., "Light N.N.E. breeze; water still discoloured. Have seen two cuttle-fish to-day, and much weed, not unlike *grass*, in the water. On examination, it looked like grass which grows in fresh water, and has been attached at the root to rock or soil, from which it appears to have been broken very recently. Current South, 20 miles daily, for the last three days." (1855). Eastward of Cape Verdes, "Quantities of *fish spawn* on the surface of the sea, of a brown colour." (1860). In 20° N., 34° W., "The sea is covered with a *yellow substance*, apparently like dust. Cannot see its extent North and South; it is about 7 or 8 miles S.W. and N.E. Many dolphins and a few flying-fish seen. Wind S.S.E., force 2."

Gulf Weed.—Numerous instances of Gulf Weed observations are recorded, especially between 30° and 40° W., and 18° to 20° N. It was also observed, less frequently, between 15° and 18° N. and 20° to 30° W. In July (1 obs.) and November (1 obs.) in 12° N., 25° W. In January (1 obs.) and April (1 obs.), 150 miles S.W. of Cape Verde, in which position it must have been placed by the North African Current, as must also the following:—In 8° N., 16° W. (1862), "A quantity of weed floating about; it proved to be *fucus natans*, covered with a green weed."

Between the Equator and 10° N. (Squares 2, 3, and 4) all fish (and their food), excepting *Bonitos* and *Flying-Fish*, were very much confined to the part of the squares where the two Trades meet.

March (1858).—In 1° N., 20° W., "Passed patches of *spawn*." In 8° N., 30° W., "Passed close to an immense *turtle*." In 4° N., 20° W., "Patches of spawn, having the appearance of *white froth*."* In

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* The float of the *Ianthina* presents the appearance alluded to in the above remark, as its shell is not seen from a ship's deck.

3° N., 24° W., "Caught a number of small creatures of remarkable beauty in colour."

April.—In the area of warmest water, about midway between St. Paul's Rocks and Cape Verde, numerous reports of *Medusæ* and *jelly-fish*. In 4° N., 24° W., "The surface of the sea covered with a *brownish dust*, the specks being from 1-20th to 1-30th of an inch long." In 3° N., 20° W., "Much *fish spawn* (?) in the last twenty-four hours." In 1° N., 21° W., "Water *very dirty*, with substance like blanket hairs; when looked at through a microscope, it appeared like fine seaweed covered with coral excrescences; also a kind of minute burr, which, when magnified, was star-shaped, the radii being extremely fine."

May.—*Medusæ* were seen between 5° and 8° N., and 19° to 22° W. *Animalcules*, in 3° N., 31° W., and in 5° N., 35° W. In Square 3, numerous observations of jelly-fish, &c.

June.—In 6° N., 26° W., "Passed a long line of *foam* and *brown matter*, about 2 ft. wide and at least 2 miles long, in which were many 'Portuguese men-of-war.'" In this month numerous *Mollusks* were seen in Square 3, between 6° and 7° N., and a school of *Blackfish*, perhaps feeding on them.

July.—In Square 3, and in 6° N., 18° W., many *luminous animalcules* seen. In 6° N., 17° W., midnight, 8th, to 4 a.m., 9th July, 1870, "Water full of phosphorescence; drew a bucket, and found it full of bag-like *jelly-fish*, each about the size of a man's thumb, and covered with small points; from the end of each point the light seemed to be emitted, the largest head or point being at the closed end of the bag, and about the size and appearance of a large pearl. Preserved some in oil." In 2° N., 31° W., (1858), "Patches of seaweed, of a *light brown colour*."

August.—(1855). In 3° N., 16° W., "Passed through great quantities of *animalcules*, in layers, from 40 to 50 yards distant; the water was luminous all round." (1864). In 1° N., 23° W., "Large quantities of *Medusæ* seen this afternoon; water exceedingly luminous after sunset." In Square 3, *Medusæ effulgens* and other gelatinous creatures seen.

September.—In 5° N., 18° W., "Numerous *jelly-fish* floating about." In lat. 3° to 6° N., long. 23° to 26° W., "Sailed through a batch of 'Portuguese men-of-war;' they were in a *rippling* which extended in a line East and West. No more than twenty or thirty were seen before or after. They were unusually large, bright-coloured, pink and blue. This was just after we had sailed from South and S.W. winds into different weather, and just after a heavy shower of rain (ship going North)." In 3° N., 23° W., "Some Portuguese men-of-war, large and blue, with pink-edged sails. I have never found them in the easterly currents hereabout, only in the westerly." In 6° N., 28° W., "Water appears to be full of *animalcules*." In Square 3, numerous notices of *animalcules;* and in 6° N., 24° W., "A quantity of *yellowish matter*, resembling fish spawn."

November.—(1856 and 1860). In the parallel a little North of Sierra Leone, *vegetable matter* (evidently from some of the rivers) was observed floating on the water as far West as 19° W.; seaweed was also seen (several large pieces, 1863), in 7° N., 14° W. In Square 3, birds, fish, and their *food*, seem to have abounded between 4° and 5° N., where the easterly and westerly currents meet.

December.—In lat. 7° N., 22° W., "Several pieces of *greenish seaweed.*" In 6° N., 21° W., noon, "Passed a *large tree*, evidently torn up by the roots. It appeared about 40 ft. in length." In 3° N., 22° W., "A large stream of something like *dirty oil* or *grease* floating on the water." In 8° N., 27° W., "Numerous *mollusks* floating past, in shape and size like a mushroom."

Between the Equator and 10° S. (Squares 301, 302, 303, see diagram, page 481). *January.*—(1858). In 4° S., 31° W., "A strong smell of seaweed, as on a sea-beach, with plenty of weed at low water. In 6° S., 32° W., the captain says the smell came from a substance on the water resembling oil." (1868). In 5° S., 33° W., a captain remarks the curious circumstance, which, although not directly referring to our subject, is still worth quoting. "From the observations of many others, as well as from personal experience, I mention that the birds in the vicinity of the Rocas and St. Paul's Rocks are invariably to the eastward of them, only stray ones to leeward." Off Pernambuco (1857), "Passed over a large quantity of *whale-dung.*"

March.—In 4° S., 19° W., *Medusæ* and *animalcules* reported. On the Equator, in 20° W. (1860), "Passed a small piece of seaweed like *sargasso.*" In 9° S., 33° W., off Pernambuco, "Passed through a narrow belt of water, its surface covered with a thick deposit of *vegetable matter.*"

April.—*Jelly-fish* and *medusæ* have been seen (1866) in 1° S., 21° W.; (1868) in 2° S., 22° W.; and (1857) in 3° S., 27° W. Off Pernambuco to the S.E. (1866), "*Water quite thick* with the seed of seaweed."

July.—In 2° S., 15° W., *Medusæ* (phosphorescent). In 5° N., 18° W., "A great number of *jelly-fish* floating about in large patches."

August.—In 5° S., 29° W., many snake-like *gelatinous creatures* seen. In 10° S., 31° W., "Water full of *animalcules.*" In 9° S., 34° W. (1860), "Much *seaweed* about, leaf oblong, with prickly point like holly, yellow colour, berries upon it single, not in clusters. Little crabs and fish amongst it in great abundance." A sketch is given in the log, which resembles *Sargasso weed;* also sketches of the crabs, &c.

September.—In 4° S., 15° W., "A *mass of scum* travelling with the wind; it had a brownish appearance." Similar colouring matter was noticed in 6° S., 17° W., over a quarter of a mile of the sea, in streaks, at short distances apart.

December.—On the Equator, 20° W. (1860), "Passed through a long *streak of foam*, extending N.W. and S.E. as far as the eye could reach."

In July, 1886, Capt. Page, of the brig *Manson*, between a position in lat. 21° 5′ N., long. 21° 14′ W., and another in lat. 17° 41′ N., long. 19° 44′ W., observed the water to be of a pale green colour, and highly phosphorescent at night. No bottom was found at 125 fathoms.

On July 28th, 1887, in lat. 6° 24′ N., long. 53° 34′ W., Capt. Green, of the ship *Erato*, reported that the water appeared perfectly black, and when broken by the vessel was very dark green. The thermometer at noon stood at 84° F.

4.—AN ACCOUNT OF THE FINE DUST WHICH OFTEN FALLS ON VESSELS IN THE ATLANTIC OCEAN.

By Charles Darwin, Esq., F.R.S., F.S.S.

Many scattered accounts have appeared concerning the Dust which has fallen in considerable quantities on vessels on the African side of the Atlantic Ocean. It has appeared to me desirable to collect these accounts, more especially since Professor Ehrenberg's remarkable discovery that the dust consists, in considerable part, of *Infusoria* and *Phytolitharia*. I have found fifteen distinct statements of Dust having fallen; and several of these refer to a period of more than one day, and some to a considerably longer time. Other less distinct accounts have also appeared. I will here only refer to the more striking ones, and make a few general remarks.

The phenomenon has been most frequently observed in the neighbourhood of the Cape Verde Archipelago. The most southern point at which Dust is recorded to have fallen is noticed by Captain Hayward,[*] on whose vessel it fell whilst sailing from lat. 10° N. to 2° 56′ N.; the distance from the nearest of the Cape Verde Islands being between 450 and 850 miles. Respecting the northern limit, the water for a great distance on both sides of Cape Noon (in lat. 38° 45′) is discoloured, owing in part, according to Lieut. Arlett,[†] to the quantities of falling Dust. Hence the phenomenon has been observed over a space of at least 1,600 miles of latitude. This Dust has several times fallen on vessels when between 300 and 600 miles from the coast of Africa: it fell, in May, 1840, on the *Princess Louise*,[‡] (in lat. 14° 21′ N., long. 35° 24′ W.), when 1,030 miles from Cape Verde, the nearest point of the continent, and therefore half-way between Cayenne in South America and the dry country North of the Senegal in Africa.

On January 16th, 1833, when the *Beagle* was 10 miles off the N.W. end of St. Jago, some very fine dust was found adhering to the under-side of the horizontal wind-vane at the mast-head; it appeared to have been filtered by the gauze from the air, as the ship lay inclined to the wind. The wind had been for twenty-four hours previously E.N.E., and hence, from the position of the ship, the Dust probably came from the coast of Africa. The atmosphere was so hazy, that the visible horizon was only 1 mile distant. During our stay of three weeks at St. Jago (to February 8th), the wind was N.E., as is always the case during this time of the year; the atmosphere was often hazy, and very fine Dust was almost constantly falling, so that the astronomical instruments were roughened, and a little injured. The Dust collected on the *Beagle* was excessively fine-grained, and of a reddish-brown colour; it does not effervesce with acids, and easily fuses under the blow-pipe into a black or grey bead.

In 1838, from the 7th to the 10th of March, whilst Lieut. James, in H.M.S. *Spey*, was sailing, at the distance of from 330 to 380 miles from the African continent, between lat. 21° 10′ N., long. 22° 14′ W., and lat.

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[*] Nautical Magazine, 1839, page 364. [†] Geographical Journal, vol. vi., page 296.

[‡] Edinburgh New Philosophical Journal, vol. xxxii., page 134.

17° 43' N., long. 25° 54' W., considerable quantities of Dust fell on his vessel. The Dust which fell on the 7th, was preceded by a thick haze, and it is coarser than that which fell on the succeeding days. It contains numerous irregular, transparent, variously-coloured particles of stone about 1-1000th of an inch square, with some few a little larger, and much fine matter. The fact of particles of this size having been brought at least 330 miles from the land is interesting, as bearing on the distribution of the sporules of cryptogamic plants and the ovules of *Infusoria*. The Dust which fell on the three succeeding days resembles in appearance, and in its action under the blow-pipe, that collected by myself off St. Jago, and is so excessively fine, that Lieut. James was obliged to collect it with a sponge moistened with fresh water. As the wind continued nearly in the same direction during the four days, and the distance from the land was only a little increased after the first day, it would appear probable that the coarser Dust was raised by a squall with which the breezes on this coast so often begin blowing.

With respect to the direction of the wind during the falls of Dust, in every instance, where recorded, it has been between N.E. and S.E.; generally between N.E. and East. In the case, however, given by the Rev. W. Clarke,* a hazy wind which had blown for some time from East and S.E., first fell calm, and was succeeded for a few hours by a S.W. wind, and then returned strongly to the East; during this whole time Dust fell. With respect to the time of year, the falls have always occurred in the months of January, February, March, and April; but in the case of the *Princess Louise*, in 1840, as late as May 9th. In the year 1839, Dust was recorded as having fallen in the Atlantic on January 14th and 15th, and on February 2nd, 4th, 9th, 10th, 11th, 12th, and 13th. I may add, that Baron Roussin,† during his survey of the north-western African coast, found that, whilst the wind keeps parallel to the shore, the haze and Dust extend seaward only a short distance; but when during the above four specified months, the Harmattan blows from the N.E. and E.N.E., accompanied by tornados, the Dust is blown far out, and is raised on high, so that stars and all other objects within 30° of the horizon are hidden.

Another account is given by Mr. George Peacock, as having occurred on board H.M.S. *Winchester*, in February, 1829:—"Shortly after leaving Tenerife, when in about lat. 25° 30' N., and some 250 miles from the coast of the Great Desert of Sahara, the weather became very hazy and sultry, and one morning, at daylight, the lays of the lower rigging were observed to be filled with fine, reddish-brown Dust, and the decks, whilst being washed, were in as muddy a state as the pavement of a street after a shower. This hazy unpleasant weather continued all day, and quite obscured the horizon, rendering it difficult to observe even the crest of the waves beyond a few cables' lengths, and the sun appeared as viewed through the red shade-glass of a sextant. Towards evening it grew worse, the wind became light, and the haze was almost as dense as a London November fog, the air full of fine red Dust, which made it difficult to breathe.

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* Proceedings of the Royal Geographical Society, vol. iv., page 145.

† Nautical Magazine, 1838, page 824.

So thick was it, that a young man having fallen overboard, the boats which were lowered in search of him could neither find him, nor scarcely find the ship for some time afterwards, and this though guns were fired."

From the several recorded accounts,* it appears that the quantity of Dust which falls on vessels in the open Atlantic is considerable, and that the atmosphere is often rendered quite hazy; but nearer to the African coast the quantity is still more considerable. Vessels have several times run on shore, owing to the haziness of the air; and Horsburgh† recommended all vessels, for this reason, to avoid the passage between the Cape Verde Archipelago and the mainland. Roussin, also, during his survey, was thus much impeded. Lieut. Arlett found the water so discoloured,‡ that the track left by his ship was visible for a long time; and he attributed this, in part, to the fine sand blown from the deserts, "with which everything on board soon becomes perfectly caked."§

Professor Ehrenberg has examined the Dust collected by Lieut. James and myself; and he finds that it is in considerable part composed of *Infusoria*, including no less than sixty-seven different forms. These consist of thirty-two species of siliceous-shielded *Polygastrica;* of thirty-four forms of *Phytolitharia*, or the siliceous tissues of plants; and of one *Polythalamia*. The little packet of Dust collected by myself would not have filled a quarter of a teaspoon, yet it contains seventeen forms. Professor Ehrenberg remarks that, as thirty-seven species are common to several of the packets, the Dust collected by myself, and on four successive days by Lieut. James, must certainly have come from the same quarter; yet mine was brought by an E.N.E. wind, and Lieut. James' by a S.E. and E.S.E. wind. The *Infusoria* are all old known species, excepting one allied to a Hungarian fossil; and they are of fresh-water origin, with the exception of *Grammatophora oceanica* and *Textilarea globulosa*, which are certainly marine. Professor Ehrenberg could not detect any of the soft parts of the Infusoria, as if they had been quickly dried up, and hence it would appear that they must have been caught up by the wind some time after their death.

The greater number of the species are of wide distribution; four species are common to Senegambia and South America, and two are peculiar to the latter country; moreover, it is a very singular fact, that out of the many forms known to Professor Ehrenberg as characteristic of Africa, and more especially of the Sahara and Senegambia regions, none were found in the Dust. From these facts, one might at first doubt whether the Dust came from Africa; but considering that it has invariably fallen with the wind between N.E. and S.E., that is, directly from the coast of Africa; that the first commencement of the haze has been seen to come on with these winds; that coarser particles have first fallen; that the Dust and hazy atmosphere are more common near the African coast than farther in the Atlantic; and, lastly, that the months during which it falls coincide with those when the Harmattan blows from the continent, and when it is known that clouds of dust and sand are raised by it, I think that there can be no doubt that the Dust which falls in the Atlantic does come from Africa. How to explain the enigma of the absence of characteristic African forms, and of the presence of two species from South America, I will not pretend to conjecture.

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* Nautical Magazine, 1837, page 291; Edinburgh Philosophical Journal, vol. vii., page 402; Howard Malcolm's Travels, vol. ii., page 200.

† Horsburgh's East India Directory, page 11.

‡ In Tuckey's Narrative of the Congo Expedition, page 10.

§ Nautical Magazine, 1847, page 354.

Finally, I may remark, that the circumstance of such quantities of Dust being periodically blown, year after year, over so immense an area in the Atlantic Ocean, is interesting, as showing by how apparently inefficient a cause a widely-extended deposit may be in process of formation; and this deposit, it appears, from the researches of Professor Ehrenberg, will in chief part consist of fresh-water *Polygastrica* and *Phytolitharia*.

This concludes Professor Darwin's remarks.

About 30 years later, Dr. Hellmann collected a series of observations from ships' logs, and from his and later examinations there seems but little doubt that the source of this Dust is in the African deserts, and that the Trade Wind is the means of its dispersal. It has been found nearly as far North as the parallel of Cape Juby, in long. 37° W., and as far South as that of Cape Palmas, in 31¼° W. The westernmost observation was in 15° N., 40¼° W., about midway between Cape Blanco and Trinidad. It is most frequently observed in the winter months, especially January and February, and the area of its greatest frequency is around the Cape Verde Islands, or between lat. 10° and 20° N., long. 20° and 30° W.*

Of a merchant-fleet from St. Helena, under convoy, in November, 1813, most of the ships had their sails covered with *red* sand, and they must have been from 400 to 500 miles from shore, in about 27° and 28° N., after a succession of easterly winds. "I once," says Mr. Luccock, "saw the sails and deck of a vessel covered with it, when 400 miles from the coast, and have heard of the same phenomenon being remarked at a far greater distance. This moving expanse of sand was probably, at some anterior period, a large inland shallow sea, communicating with the Mediterranean by the Syrtes (Gulf of Sydra), &c."

A similar phenomenon occurred to the brig *Parssboro'*, on her voyage from Barbados to Belfast, and when she was upwards of 900 miles from the mainland of Africa. The wind had been at East, and was interrupted by one of those gales noticed in our description of the Azores. "In lat. 30° 50′ N., long. 32° 40′ W., Cape Verde Islands bearing S.E., distant 590 miles, the appearance of a heavy squall rising in the S.E. direction. At $6^h 30^m$ p.m., lightning, thunder, and the squall approaching. The sun, about 15° above the western horizon, became overcast with peculiar-looking clouds, and every appearance of an approaching storm. I consequently shortened sail, although the barometer did not indicate anything serious. At 8 p.m., the wind became very variable, from N.E. to S.W., every ten or fifteen minutes alternately, for two hours. There was a fall of rain when the heaviest of the squall was on the zenith. At midnight it had all passed to the S.W., and the wind resumed its former place,

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* "Die Staubfalle im Passatgebiete des Nordatlantischen Ozeans," von J. von Goerne, in "Globus," Band lv., 1889, pages 241—244.

East. At daylight, *the decks, rigging, spars, and paint-work were covered with mud:* and as the sun dried it, it had the appearance of a very fine red mould, with no sand in it."

The following further information on this subject is derived from fifty-nine observations of Red Dust recorded in the log-books examined at the Meteorological Office, in the study of the region between lat. 10° S. and 20° N. from long. 10° to 40° W. Of these, only one occurs in Square 38; 24 in Square 39; and 14 in Square 40; 13 in the northern half of Square 3; and 7 in the northern half of Square 4 (see diagram, page 481). In the different months the numbers are as follow:—January 12, February 5, March 6, April 12, May 1, June 5, July 3, August 0, September 0, October 3, November 0, December 12.

The *most Westerly* observations are:—Lat. 17° 30′ N., long. 38° 30′ W., 10 a.m., April 13th, 1859: Red Dust still falling; wind N.E. by E., force 4. In lat. 14° 30′ N., long. 37° 30′ W., 10 a.m., April 12th, 1859: Red Dust still falling in large quantities; wind N.E. by E., force 4. In lat. 12° 30′ N., long. 38° 30′ W., 4 p.m., December 29th, 1865: Sails tinted with "cloud" Dust; wind E. by N., force 6. At 6 a.m. the clouds were said to be tinted brick-dust colour. At noon, indications of "cloud" Dust. The most *Southerly* observation is in lat. 4° 30′ N., long. 24° 30′ W., January 15th, 1866: Our sails coloured quite red with African Dust; wind N.E.

On February 24th, 1879, a heavy S.S.E. gale brought a thick layer of similar Red Dust over the city of Naples; this was considered to have come from the African deserts.

On March 4th, 1889, a fall of yellow Dust, probably blown off the American coast, was experienced on the *Oscar*, Capt. Le Moult, in lat. 30° 4′ N., long. 70° W., or about 420 miles from the coast. A fall of red Dust was also experienced near this position on April 3rd, 1884, on the ship *Ida*, Capt. Schneider.*

Land-birds and *Insects* are frequently seen far out at sea; and in the region we are now treating of, the ships' logs record many instances, by far the most numerous naturally occurring between longitudes 20° and 30° W., or in the tracks of vessels to the Equator. The latitude, however, points to West Africa as the origin of these remarkable wanderers; between 3° and 10° N. (long. 20° to 30° W.) about 75 observations are recorded, while between 3° N. and 10° S. only 9 reports. It would clear up many doubts, if the *species* of the various strays was known; doubtless, many of the insects were shipped in the caterpillar or chrysalis state, and emerged as perfect insects during the voyage. Some of the land-birds, too, no doubt, had escaped from passing vessels.

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* "Staubfälle im Nordatlantischen Ocean," in "Annalen der Hydrographie," 1889, pages 450—454. See also same for 1891, pages 313—318.

5. THE DEPTH, TEMPERATURE, ETC., OF THE NORTH ATLANTIC OCEAN.*

DEEP-SEA SOUNDING.—Previous to the introduction of submarine telegraph cables, comparatively little had been done in the way of systematically exploring the depths of the ocean, and much doubt was held regarding the correctness of many of the deep soundings taken. In the earlier experiments, which were made with small line quite incapable of bringing back the lead, it is evident that at times the indication of having reached the bottom, by the line ceasing to run, could not be altogether satisfactory.

It was formerly considered that the lower stratum of ocean-water in great depths was, from the pressure and weight of the incumbent mass, so dense as to be rather of the nature of solid matter than the natural fluid. However, a few facts will serve to dispel such a notion. The descent of the deep-sea lead is quite as rapid at a depth when the upper weight must be enormous, as at less distances from the surface, and no tendency to obstruct its downward passage can be observed at the greatest depth yet attained, except that which is due to the friction on the sounding-line. Again, the whale-fishers frequently find their prey to descend perpendicularly to such enormous depths, that the idea of an impenetrable density, or even of any considerable increase of it, cannot be for a moment entertained.

It is true that the pressure increases with the depth, to the amount of 15 lbs. upon the square inch for every 34 feet in depth, or 225 lbs. for every 100 fathoms, which is a little over 1 ton on the square inch for every 1,000 fathoms; but the density is not thereby sensibly increased, owing to the comparative incompressibility of water; so that neither the buoyant force, nor the resistance to the motion of any body, are materially increased from the surface to the bottom. At the depth of 3,000 fathoms, for instance, the pressure upon a square inch is nearly 8,000 lbs., but the column of water of 18,000 feet is only shortened by about 160 feet. At a depth of 2½ miles the increase of *Density* is not equal to the difference in the density between fresh and salt water. Dr. W. A. Miller calculated it would at that depth be equal to one forty-seventh of its volume, while sea-water, at the mean specific gravity of 1·027, is one thirty-seventh heavier than fresh water. There is, therefore, not the slightest difficulty in understanding that the sounding-lead or telegraph cable would sink uniformly from the surface to the greatest depths; and not only such heavy weights, but even that the delicate organisms and remains of microscopic animals which have lived on the surface, may quietly sink to the bottom, and there add to the immense deposits which are now shown to exist everywhere over the ocean-bed.

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* The chief authorities consulted on the subjects dealt with in this Section are as follow:—"The Atlantic Deep-Sea Bed and its Denizens," by Dr. G. C. Wallich, 1864; "The Depths of the Sea," 1873, and "The Voyage of H.M.S. *Challenger*; the Atlantic," 2 vols., 1877, by Sir C. Wyville Thomson; "Thalassa; an Essay on the Depth, Temperature, &c., of the Ocean," by J. J. Wild, 1877; "Notes by a Naturalist on the *Challenger*, by H. N. Moseley, 1879; "Deep-Sea Sounding and Dredging," by Lieut. C. D. Sigsbee, U.S.N., 1880, well illustrated with photographs; "On Deep-Sea Sounding, in Connection with Submarine Telegraphy," a Paper read before the Society of Telegraph Engineers, by E. Stallibrass, 1887; "Den Norske Nordhavs-Expedition, 1876—1878," part xviii., 1887, (in English) by Dr. H. Mohn, on "The Depth, Temperature, and Circulation of the Northern Ocean;" "Three Cruises of the U. S. Coast Survey Steamer *Blake*," 2 vols., by Alexander Agassiz, 1888, profusely illustrated with sketches of apparatus, forms of deep-sea life, &c.;" "Océanographie (Statique)," by M. J. Thoulet, 1890, a most interesting work;" the "Reports on the Scientific Results of the Voyage of H.M.S. *Challenger*," a series of monumental richly illustrated volumes, including that on "Deep-Sea Deposits," by Dr. J. Murray and Prof. A. F. Renard, 1891, and those on "Physics and Chemistry," 2 vols.; and, lastly, "Geophysikalische Beobachtungen der Plankton-Expedition," by Dr. O. Krümmel, 1893. "Fauna of the Deep Sea," by S. J. Hickson, M.A., 1894, contains, in a small compass, a great deal of interesting matter concerning the deep sea and its inhabitants.

But little importance can be attached to deep-sea soundings taken previously to the beginning of the nineteenth century. Among the earliest reliable experiments, perhaps the first, of these deep-sea soundings, is that recorded by Sir James Ross, who, during the Arctic Expedition of 1818, obtained specimens of the bottom from depths exceeding 1,000 fathoms. On November 13th, 1822, Captain (afterward General Sir) Edward Sabine, when about midway between the Caymans and Cape Antonio, in the Caribbean Sea, sank a cylinder and obtained the temperature at a depth exceeding 1,000 fathoms. This was followed by Captain Wauchope, in H.M.S. *Eurydice*, who gained water from a depth of about 1,300 fathoms. After this, many experiments were tried with more or less success, but there can be little doubt that many of the early results are not trustworthy, and are greatly in excess of the truth. At first it was not always tried to recover the lead, and the line employed was of very inferior character; and it was thought that at very great depths the friction of the water was sufficient to entirely arrest the descent of the weight.

The first attempt to use wire in deep soundings, as a substitute for hemp cord, was in 1838, during the cruise of the United States Exploring Expedition, under Captain Wilkes, but it was unsuccessful, owing to its excessive weight. On August 3rd, 1848, Captain Barnett, R.N., H.M.S. *Thunder*, when in about lat. 41° 19′ N., long. 44° 16′ W., between the Azores and Newfoundland, tried a line of *iron wire*, varying in size from Nos. 1 to 5, of 4,000 fathoms in length, wound on a small reel, the smallest part first, with a weight attached of 61 lbs. It broke at 2,000 fathoms, which ran out in $20^{m}\ 53^{s}$. This experiment was suggested by Lieutenant Mooney.

But the greatest length of wire line sent down was that effected by Lieut J. C. Walsh, in the U.S. schooner *Taney*, on November 15th, 1849, to a depth of more than 5,700 fathoms (34,200 ft., or more than 6 statute miles), without finding bottom, as was supposed, in lat. 31° 59′ N., long. 58° 43′ W., in the vicinity of the assigned position of the rocks called the False Bermudas. "The wire broke at this length, 5,700 fathoms, at the reel, and was lost. It preserved the exact plumb-line throughout the sounding; there was a steady, uniform increase of weight and tension; no check whatever any instant of its descent." This experiment, however,

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The question of connecting Europe and America by submarine electric telegraph now brought the subject of the depth of the ocean prominently to the fore, and the first trustworthy and systematic series of soundings, 34 in number, was obtained by Lieut. O. H. Berryman, in the U.S. steamer *Arctic*, in August, 1856, on the great circle joining Valentia, Ireland, with St. John's, Newfoundland. The depths were estimated by a Massey's Sounding Machine, and a similar one by M. Lecointe, and the line was wound in by a small engine on the deck.

The same round was gone over, with the same object, by Lieut. J. Dayman, in H.M.S. *Cyclops*, in June and July, 1857, and 34 soundings were obtained, the depths being estimated by the length of line and by the machine as heretofore. The sinker employed was self-detaching upon touching the bottom, and in a quill attached to the support, samples of the bottom were brought up in almost every instance in small quantities. The nature of these specimens is alluded to hereafter, and the very interesting features it first brought to light are there related.

The first failure of the Atlantic Cable having suggested the necessity of shorter sea sections of the cable, Lieut. Dayman was despatched in H.M.S. *Gorgon*, in September and October, 1858, and obtained soundings between Newfoundland, the Azores, and England, gaining much experience as to the best methods of sounding, and also of estimating the depths.

Another project for the telegraph cable, to pursue a more northern route, having arisen, in July, 1860, H.M.S. *Bulldog* started under the command of Admiral Sir Leopold M'Clintock, of Arctic celebrity, and obtained the depths between the Færoe Islands and Iceland, and thence to Greenland and Labrador, with most satisfactory results.

The subject of the Atlantic telegraph cable being still of great importance, and it being desirable that the apparent sudden dip from 550 to 1,750 fathoms on the parallel of 52° 15′ N., at about 170 miles West of Valentia, found by Lieut. Dayman, in 1857, should be avoided, H.M.S. *Porcupine* was despatched in June, 1862, and Mr. Hoskyn, R.N., made a very careful examination of the edge of the bank of soundings, between the parallels of 51° and 54° N., as well as of that between Iceland and Rockall. It will be needless to recapitulate this work—the charts are by far the best guide; but it may be said that no such sudden dip or abrupt precipice was found, the steepest incline being a difference of level of 3,060 feet in 2¾ miles, or about 19 feet in 100 feet.

Several other expeditions were afterwards organised with a view to obtaining an exact knowledge of the nature of the sea-bed, and of the depth of the ocean. The voyage of H.M.S. *Hydra*, Capt. P. R. Shortland, and that of H.M.S. *Lightning* (one of the *first two* steam-vessels built in 1825 for the Royal Navy), in 1868, with Dr. Carpenter and Dr. Wyville Thomson on board, may be cited as the most prominent. Besides these, there were the *Gannet* and *Valorous*, and the Swedish vessels *Sophia* and *Josephine*.

In 1869, H.M.S. *Porcupine* was sent out to continue these interesting researches, and under the masterly seamanship of Captain Calver, the apparatus used was brought much more nearly to perfection. The important results of this expedition in the seas N.W. of the British Isles will be briefly alluded to presently, but the topic is too wide for full notice here.*

In 1870, the U.S. vessel *Yantic* took numerous soundings in the West Indies, and in the following year the *Mercury* gained a series of 15 soundings between Sierra Leone and Havana. In 1872, the Telegraph Works Company took a series of soundings between the Lizard and Bilbao, steel wire being successfully used in place of hemp line. In 1873, the United States Government despatched the *Tuscarora* to the Pacific Ocean, under Commander Belknap, when a large series of soundings was successfully made with wire.

Up to now, the most extensive deep-sea exploring expedition was conducted on board H.M.S. *Challenger*, between December, 1872, and May, 1876, a period of three years and five months, three years of which were spent between lat. 40° N. and 40° S. Elaborate investigations were made in each of the great Oceans of the globe, and it may be interesting to record, that during this lengthened voyage, the ship sailed and steamed over upwards of 68,000 miles, and nearly 400 deep soundings were taken, of which two were over 4,000 fathoms, nine between 3,000 and 4,000 fathoms, 168 between 2,000 and 3,000 fathoms, 124 between 1,000 and 2,000, the remainder being under 1,000 fathoms. There were 360 observing stations established, at each of which, as far as circumstances would permit, the exact depth was determined; samples of the bottom from 1 oz. to 1 lb. were obtained; samples of water from the bottom and from various depths were procured for physical and chemical examination; the bottom and intermediate temperatures were determined; at most stations a fair sample of the bottom *fauna*, and of that of intermediate depths, was obtained by the dredge or trawl variously adjusted;

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* See "Proceedings of the Royal Society," vol. xviii., No. 181, for a full report of the voyage.

atmospheric and meteorological observations made; and the direction and rate of the surface (and in one or two cases of sub-surface) currents were determined. In the North Atlantic Ocean, 130 soundings were taken, and other observations made (December 30th, 1872, to August 30th, 1873), between Portsmouth and Tenerife, Tenerife and St. Thomas in the Caribbees, St. Thomas and Bermuda, Bermuda and Halifax, having crossed the Gulf Stream in a north-westerly direction, Halifax and Bermuda, Bermuda and Madeira, Madeira and Bahia, crossing the eastern portion of the Guinea Current in a southerly direction. On the return voyage in 1876, crossing the Equator in about 14° 25′ W., on April 7th, Spithead was reached on May 24th.

Between the years 1874—1880, the U.S. surveying vessel *Blake*, a steamer of only 218 tons register, under the command of Captain Sigsbee, and later of Captain Bartlett, took upwards of 3,000 deep soundings with wire. During 1885—1890, the *Blake* was again occupied, under Lieut. Pillsbury, in examining the Caribbean Sea and the course of the Gulf Stream.

Telegraph cable companies now began to employ vessels and staffs of their own, to take most elaborate series of careful soundings, and a great deal of our present knowledge of the depths of the sea is due to their researches. In 1874, 1879, 1881, and 1882, Messrs. Siemens Brothers' steamer *Faraday* made a most complete examination of the region between Northern Europe and America, when the so-called *Faraday Hills* were discovered, in mid-Atlantic. These consist of several patches, with depths under 1,000 fathoms, situated between lat. 49° 35′ and 49° 50′ N., long. 28° 55′ and 29° 50′ W.; the least depth found was 625 fathoms, in lat. 49° 41½′ N., long. 29° 5′ 50″ W. A wire sounding line was used, with such accurate results, that the difference between repeated measurements at the same spots, in depths about 2,000 fathoms, rarely exceeded 2 fathoms.

Among later surveys of the depths of the North Atlantic Ocean by telegraph ships, we may mention those of the *Dacia* and *International*, between Spain and the Canary Islands, in 1883; the *Buccaneer*, in 1886, off the West Coast of Africa; the *Silvertown*, in 1884, between Senegal and the Canary Islands, and in 1889, off the West Coast of Africa; the *Minia*, in 1889 and 1893, in mid-Atlantic and off Nova Scotia; the *Silvertown*, in 1891, between the Cape Verde Islands and Pernambuco; and the *Westmeath*, in 1890 and 1892, between Halifax and Bermuda, and off and among the Caribbee Islands, the Bahamas, and Florida.

In 1881, the French Government despatched the *Travailleur*, and in 1883, the *Talisman*, to examine the seas from Western Europe to the Senegal, and among the Azores, Canary, and Cape Verde Islands, and in the Sargasso Sea, and they added much to our knowledge of the ocean. Soundings were also made by the Italian corvette *Vettor Pisani*, in 1882. Nor must we omit to mention the explorations made by the Prince of Monaco, in his yacht *Hirondelle*, during the years 1885—1888, and the expedition of the German steamer *National*, in 1889.

Careful series of soundings have also been taken by the following United States vessels:—The *Enterprise*, in 1886, between the River Plate and New York, and in 1888, between Lisbon and the Azores; the *Albatross*, in 1886 and 1887, off the American coasts, and in the Caribbean Sea and Gulf of Mexico; the *Essex*, in 1886, between the United States and Lisbon; the *Juniata*, in 1886, in mid-Atlantic, towards St. Paul's Rock; and the *Dolphin*, in 1889, between Lisbon and the United States.

Having thus enumerated the principal explorations made in the deep sea, we now proceed to give a short description of the apparatus used.

A special feature in the history of deep-sea sounding machines is the improvement in handiness and compactness resulting from the use of fine steel wire of high tenacity, instead of the hempen rope with its heavy sinkers of 4 to 6 cwt. The apparatus used in ascertaining the depth, and obtaining specimens of the bottom, has also been gradually modified to obviate the difficulties encountered. These chiefly refer to the means of detaching the sounding weights, and to the form of the apparatus which secures a portion of the bottom when it is attained.

In the *Dolphin*, 1851—1852, the soundings were taken with line ·07 inch in diameter, and one or two 32-lb. shot, but it has been questioned, and it certainly seems with reason, whether the evidence upon which the deeper soundings rest is quite valid, as before alluded to. It was considered that an approximation to the true depth obtained could be found by the rate of descent of the line, carefully estimated from numerous experiments, but this, of course, is liable to the vitiating influence of under-currents. In sounding with a line of ·07 inch in diameter, the velocity of the descent diminishes, with one 32-lb. shot, from 8·83 feet per second at 50 fathoms, to 2·84 feet at 1,000, and 2·09 feet at 2,000 fathoms; and with two 32-lb. shot, from 12·5 feet per second at 50 fathoms, to 3·48 feet at 1,000, and 2·99 feet at 2,000 fathoms; but these figures have been much modified by later experience, as referred to in the description of the wire sounding apparatus.

Another very important consideration is—what effect would under-currents have on the line in passing through it? It is certain that a current must act upon the *bight* of the sounding-line after the weight has passed through it, and it may operate in swerving the weight itself from its perpendicular descent at great depths. Again, the force exerted by a current against the *bight* of the sounding-line will have the effect of taking the twine off the reel at nearly *double* its own velocity.

From these considerations it was supposed that the depths stated, even when it was certain that the bottom had been reached, were in excess, and this, too, in an uncertain degree. But this source of error was much over-estimated. At that time, there was no experience by which a knowledge could be acquired as to the movements of the water at any considerable depth. But it is now well ascertained, that any movement which would greatly affect the registered depth ceases, as a rule, at a comparatively small depth, and that although the lower strata of ocean waters must have some circulatory movement, this motion is so slow as to be inappreciable by any means hitherto applied to estimate it on the open ocean. In laying a telegraph cable, the strain it exerts is most carefully and continuously watched by its action on the dynamometer, and the angle it makes with the surface of the sea also well noted, and these evidences accord so nearly with the calculations made for water in a quiescent state, that it is now beyond controversy, that rapid motion is confined to the upper strata.

Sir James Ross, in the Arctic Expedition of 1818, used a 2½-inch whale line for sounding, and devised a "deep-sea clam" for securing samples of the bottom, which closed by a falling weight on striking the ground. In later years, the line was carried down by a weight or spherical shot, suspended on a peculiar pair of hooks, the invention of Mr. Bonnici; when it touched the bottom, the hooks gave way automatically and dropped the weight. Lieut. Brooke, U.S.N., devised an improved form of this apparatus, the detachable weight sliding on a tube, which latter secured a specimen of the bottom. Lieut. Dayman used an improvement of the latter, on the *Cyclops*, in 1857. In the same year, the U.S.S. *Arctic* made successful use of the Massey Sounding Machine, which registers the depth on a dial attached to a revolving fan.

In H.M.S. *Bulldog's* soundings, in 1860, the depth was obtained generally by cod-line, with an iron sinker of 118 lbs., the line and sinker being lost at each sounding. The depth being thus obtained, a machine for bringing up a sample of the bottom was next sent down by a stronger line, with a self-detaching tubular sinker of 100 lbs. The apparatus which brought up specimens of the bottom was a double scoop, 5 inches in diameter, kept open so long as the weight was dependent on it, but forcibly closed by means of a vulcanised india-rubber band the moment it was detached by touching the bottom. This brought up specimens in large quantities. It was contrived by Dr. Wallich and Mr. Steil, the assistant engineer, and has been called the Bulldog Machine.

The "Hydra" Sounding Machine was invented by a blacksmith on H.M.S. *Hydra*, 1868, and this was employed on H.M.S. *Porcupine*, in 1869, for the deep soundings. Its peculiarity consists partly in the simple means of detaching the weights, a compressed spring relaxing and letting go the line which supports them; and partly in the construction of the rod which carries them, this being a strong tube furnished with valves opening upwards, so as to allow the water to stream through it freely in its descent, whilst they enclose the mud or sand into which the tube is forced on striking the bottom before the sinkers are detached. For depths of 1,000 to 1,500 fathoms, *two* sinkers, each of 112 lbs., were employed; and for yet deeper soundings *three* sinkers were used. This apparatus, as modified by Lieut. C. W. Baillie, R.N., was also used on H.M.S. *Challenger*, the sounding-line being 0·8 inch in diameter, made of the best Italian hemp, and bearing a strain of 12 cwt.

The U.S. steamer *Blake* used the "Sigsbee-Belknap" apparatus, differing principally from the foregoing in the means of detaching the sinkers. The sounding line used was of wire, No. 20 guage, capable of bearing a strain of 240 lbs., and carrying a sinker weighing 60 lbs.

The latest sounding machine, now in general use by telegraph and other deep-sea exploring vessels, is that devised by Mr. Lucas, of the Telegraph Construction Company. A complete apparatus, for depths up to 5,000 fathoms, weighs less than 2 cwt., the wire weighing about 14 lbs.

per 1,000 fathoms, and the sinker 50 lbs. A dial records the number of fathoms paid out.

A few figures will suffice to show the great superiority of wire over hemp sounding-line. In H.M.S. *Challenger*, a hemp line, with a sinker of 4 cwt., was used, and in the *International*, a wire line, 0·03 inch in diameter, with a sinker of 50 lbs. In a depth of 2,435 fathoms, the hemp line took 33 minutes to sink, and $2^h\ 2^m$ to haul up. In 2,929 fathoms, the wire took $29^m\ 45^s$ to sink, and was reeled up in $34^m\ 35^s$. Besides this, the wire can be wound in from depths up to 4,000 fathoms, while the vessel is proceeding at 8 or 9 knots, but with hemp line the vessel must remain stationary. The wire is coiled on a small drum, and passed over a pulley attached to an "accumulator," a series of springs composed of steel or india-rubber, which take off any excessive strain from the line, in case of the vessel pitching heavily.* Wire sounding apparatus is now also manufactured for ordinary ships' use; when not in frequent use, the drums of wire should be kept in a solution of caustic soda, or in oil or lime-water, to prevent oxidation.

Depth.—For a comprehensive view of this subject, which of course does not affect navigation, however interesting it may be to the physical geographer, we must refer the reader to the illustrative diagram, as a verbal account of the depths obtained in these and other voyages would convey but little intelligible information. These researches are beyond the scope of the ordinary navigator, and are here only cursorily reviewed as matters of interest. The diagram can only be considered as theoretical, the number of soundings hitherto taken being extremely small as compared with the vast extent of the Ocean.

The greatest depth hitherto found in the Atlantic Ocean is 4,561 fathoms, or nearly 5¼ *statute miles;* this depth was found in 1883, by the U.S. steamer *Blake*, in lat. 19° 41′ N., long. 66° 24′ W., about 105 miles north-westward of St. Thomas, and near where H.M.S. *Challenger* found 3,875 fathoms, in lat. 19° 41′ N., long. 65° 7′ W. The U.S.S. *Enterprise*, in 1886, found 4,529 fathoms, bottom of brown ooze, in lat. 19° 53′ N., long. 65° 45′ W. In 1889, the U.S.S. *Dolphin* found 3,441 fathoms, in lat. 30° 49′ N., long. 25° 20′ W. A depth of 3,428 fathoms was found by the U.S.S. *Blake*, in the Caribbean Sea, in lat. 19° 1′ N., long. 81° 2′ W., north-westward of Jamaica, situated in a deep trough extending from the Windward Passage into Honduras Gulf, and called by the Americans the *Bartlett Depression*.

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* The *Accumulator* is generally composed of a number of strong vulcanized india-rubber springs, combined at their extremities; and its use is two-fold:—*first*, to indicate by its elongation any excessive strain upon the sounding or dredging line, which passes through the block; and *second*, to ease off the suddenness of such strain, and give time for the action by which it may be relieved. This is specially valuable in deep-sea sounding and dredging when the vessel is pitching; for the friction of two or three miles of immersed line is so great as to prevent its yielding to any sudden jerk, such as that given to its attached extremity by a vertical motion of a few feet when the vessel rises to a sea. And it is absolutely needful when dredging is carried on from a large vessel; since, whenever the dredge fouls, the momentum of the vessel, however slowly it might be moving through the water, would cause the line to part, if the strain were sudden instead of gradual.

Deep-Sea Deposits.—The materials composing the bed of the Ocean may be divided into two classes, according as they have been derived from the land or the sea. *Terrigenous Deposits*, or those derived from the degradation of adjacent land surfaces, do not extend as a rule more than 300 or 400 miles from the shore, but powerful ocean or river currents would carry them much farther; in these, it is thought, that compound rocks, such as now exist, can be recognised in process of formation.

Pelagic Deposits are formed with extreme slowness, in the deep water of the central regions of the great ocean basins, and consist of organic oozes and a reddish clay. They are chiefly made up of the calcareous and siliceous remains of organisms which have fallen from the surface water, along with clay and decomposing volcanic débris. These do not appear to bear any relation to the known marine stratified rocks.

Between the depths of 400 and 2,000 fathoms, the floor of the Atlantic Ocean is, in general, covered with a whitish mud, formed by the shells of *globigerina* and other foraminifera, identical with those in chalk. These are rarely found in depths beyond 2,500 fathoms. In the deepest parts, the floor is a sort of red clay, with granules of manganese and iron, supposed to be of meteoric origin.

It is probable, however, that there is no invariable rule of the quality of the bottom depending on the depth. For instance, in ten soundings between 2,000 and 3,000 fathoms, off the United States coast, in 1884, the *Albatross* found a bottom of *globigerina* ooze. The following is a short description of the principal Pelagic Deposits.

Red Clay, with which it is conjectured that more than one-fourth of the globe's area is covered, is found in great depths, remote from land. It is soft and greasy to the touch, and a specimen from a depth of 3,150 fathoms, in the North Atlantic Ocean, was found to consist of 53·30 silica, 17·40 alumina, 11·70 ferric oxide, with traces of lime and magnesia. It is considered to be derived mainly from the decomposition of volcanic materials. The *Manganese Nodules*, found with this deposit, usually contain about 35 per cent. peroxide of manganese, with some 25 per cent. of ferric oxide; cobalt, with copper, and a little nickel, are present in all of them, according to Mr. Buchanan.

Radiolarian Ooze is only found in the greatest depths, and has not been found in the Atlantic. It consists of a basis of Red Clay, with a large admixture of siliceous organisms.

Diatom Ooze is only found in the South Polar regions, and in the N.W. part of the North Pacific Ocean.

Globigerina Ooze appears to occupy all the medium depths of the Ocean, away from land, and consists mainly of carbonate of lime, formed from the dead shells of foraminifera, which, when living, abound on the surface of the sea.

Pteropod Ooze is similar to the last, and is found on the central Atlantic ridges, and contains shells of mollusca, which also live on the surface.

In 1883, the *Talisman* examined the Sargasso Sea region, and obtained from the bottom a collection of volcanic lava and scoriæ, some appearing to be of comparatively recent origin.

TEMPERATURE.—In recent times a great amount of attention has been given to the subject of the Temperature of the Waters of the Ocean, from the surface to the bottom, as affording a clue to the system of its circulation. Allusion has already been made to this in (247) page 298, and in (362) page 377. In the earlier experiments, all enquiries into deep-sea Temperatures appear to have been alike deceptive and unsatisfactory, as the indications obtained, even by the most careful observers, with the best of instruments, were utterly at variance with any theory that could associate Temperature as a leading cause of the circulation of the waters of the Ocean. Thus, temperatures that reason would expect to find—say 30° F.—at great depths, were made to appear to be 42° or 43°, the disparity being less as the depth diminished.* This was caused by the elasticity of the glass bulbs yielding to the pressure of the water, though they recovered their normal condition on reaching the surface, so that the effect of this pressure remained unknown.

Protected bulbs for *Deep-Sea Thermometers* had been devised by Admiral FitzRoy, and used by Capt. Pullen in the Atlantic and Indian Oceans, but the principle was forgotten until revived and carried out again, as related by Dr. J. J. Wild, in "Thalassa," pages 31—34. He says:—"The want of an efficient deep-sea thermometer, which more or less vitiates all the observations of earlier explorers, was especially experienced during the cruise of H.M.S. *Lightning* in 1868, the first expedition fitted out for sounding and dredging purposes by the joint cooperation of the Royal Society and the English Admiralty. Of the thermometers used on this occasion, several returned to the surface broken by the pressure to which they had been exposed, and the indications given by the rest varied so much as to render the discovery of a thermometer free from this error a matter of paramount importance for the success of future deep-sea exploration. By a happy coincidence, the desired improvement was effected at the moment when a second expedition was being prepared.

"In April, 1869, previous to the departure of H.M.S. *Porcupine* on her first cruise, at a meeting of the Deep-Sea Committee of the Royal Society of London, Dr. W. A. Miller suggested a simple expedient for protecting thermometers from the effects of pressure, which was ably carried out by Mr. L. P. Casella, F.R.A.S., the eminent scientific instrument maker to the Admiralty, and resulted in the construction of an almost perfect instrument for recording the temperature at great depths.* One of the essential qualities of an instrument intended for use on long voyages is that it should be portable—a quality especially realised by Mr. Casella in the construction of his thermometer. By contracting the bore of the glass tube as much as possible, the quantity of the liquids, particularly of the mercury, was reduced to a minimum; and the liability to accident, almost inseparable from instruments containing large quantities of this heavy substance, was thus greatly reduced.

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* Mr. Prestwich collected these series of observations, as they form a valuable supplement to those collected since 1868. See "Tables of Temperatures of the Sea at Various Depths below the Surface, taken between 1749 and 1868, collated and reduced, with notes and sections," by Joseph Prestwich, F.R.S., F.G.S., in the "Proceedings of the Royal Society," No. 154, 1874.

Much recent information on this subject is given in the works mentioned in the note on page 916, and the following have also been referred to, in dealing with this section. The "Wind and Current Charts" issued by the Meteorological Office, in 1872, and referred to on page 294, &c., and "Charts showing the Surface Temperature of the Oceans," issued in 1884; "Further Enquiries on Oceanic Circulation," in the "Proceedings of the Royal Geographical Society," vol. xviii, 1874, and a Paper "On the Temperature of the Deep-Sea Bottom," in the "Proceedings," vol. xxi, 1877, both by Dr. Wm. B. Carpenter, F.R.S.; and "Wissenschaftliche Ergebnisse einer Forschungsreise zur Zee, in 1891 und 1892," by Dr. G. Schott, in "Ergänzungsheft No. 109 zu Petermann's Mitteilungen," 1893, which contains a great deal of interesting matter concerning Temperature, Specific Gravity, Currents, &c.

"The cruise of H.M.S. *Challenger* afforded ample opportunities for testing the capabilities of the *Miller-Casella Thermometer*. It resisted all the pressures to which it was exposed down to a depth of about 4,000 fathoms, when some of the instruments were found to give way under a pressure of four tons to the square inch; but as depths of from 4 to 5 miles are exceptional, such accidents will be of rare occurrence. Under a pressure of three tons, equivalent to a depth of 3 miles, the error amounts to less than 1° C. (2° F.), whilst that of the unprotected thermometers, previously in use, sometimes exceeded 10° C. (18° F.) for the same depth; and a comparison of the data furnished by the Miller-Casella Thermometer with the corresponding Temperature Curves shows that the mean error of all the deep-sea observations made on board H.M.S. *Challenger*, not much under 10,000 in number, is probably less than 0·5° C.

"The Thermometers, before being sent out, are subjected to pressures varying from one to four tons to the square inch, in a hydraulic press especially designed for this purpose by Mr. Casella, and the amount of error ascertained for each instrument. When in actual use, they are enclosed in a copper cylinder, perforated at both ends, to allow free ingress and egress of the water. Several Thermometers may be attached to the same sounding-line, whilst it is being paid out, at distances of 5, 10, 25, 50, or 100 fathoms as required; and it is found that an immersion of from five to ten minutes is sufficient to secure the desired record of temperature.

"Since all the observations made on board H.M.S. *Challenger*, during her cruise round the world, were obtained, and the true Temperature of the sea determined by means of this instrument, now known as the Miller-Casella Thermometer, a description of it in these pages may not be out of place.

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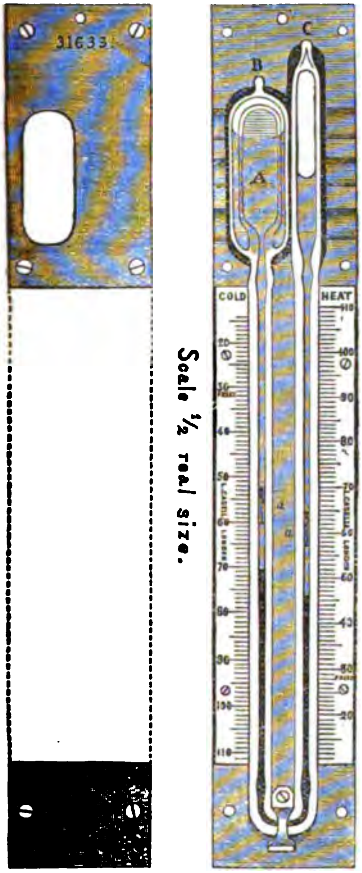
* In experiments with the hydraulic machine, constructed to test the effect of pressure on the thermometers employed, a standard registering thermometer, shielded in a stout glass cylinder, was placed in the water together with one of the deep-sea thermometers, and the water was compressed to an extent equal in pressure to about 3 miles of depth in the sea. All previous suspicions of errors were fully confirmed, as the pressure on the bulb was found to cause an error of 12° to 13° F. at this depth. Notwithstanding the great pressure to which these instruments had been subjected, all of them, without exception, recovered their original scale-readings as soon as the pressure was removed.

"THE MILLER-CASELLA THERMOMETER, as will be seen from the accompanying figures is designed to register the maximum and minimum temperature of the water to which it is exposed during its descent from the the surface of the sea to the bottom. For this purpose, the glass tube is bent in the shape of the letter U, each arm of the tube terminating in a bulb. The larger bulb, A, is surrounded by another bulb, B, and about three-fourths of the space between the two bulbs is filled with alcohol. It is by the addition of this outer bulb, B, that the protection of the instrument from the effects of pressure is secured.

"On immersion, the outer bulb receives the pressure of the water, and forces the enclosed alcohol into the portion of the intervening space previously not occupied by this liquid, thus relieving the inner bulb, A. The latter is completely filled with a mixture of creosote and alcohol, which rests upon the mercury contained in the bend of the tube, and also fills up the other arm and part of the bulb C. The upper part of bulb C is occupied by air, introduced, with the help of a freezing mixture, at a very low temperature, in order to increase its elastic force. It thus acts as a sort of elastic cushion, intended to overcome the weight and friction of the mercury in the tube, and to assist the mercury in following the mixture when contracting under the influence of cold.



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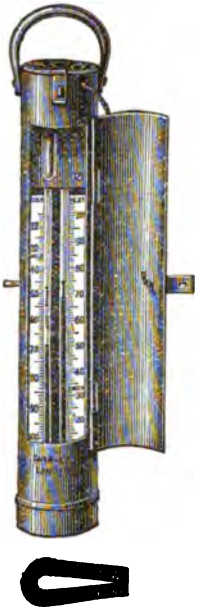

Miller-Casella Thermometer, in case.

"The indications of the thermometer depend upon the expansion by heat and contraction by cold of the mixture contained in bulb A. When expanding, the mercury is forced down in the arm attached to this bulb and rises in the other arm towards bulb C; when contracting, the mercury falls on the side of bulb C, and rises towards bulb A. Two steel indices, *a, a,* covered with glass, mark the maximum height which the mercury has reached in either arm, and a hair attached to each index produces the friction necessary to retain them at the level to which they have been raised. Before the thermometer is lowered into the sea, the indices are brought down upon the mercury by passing a magnet along the tube."

Negretti and Zambra's Deep-Sea Thermometer.—It having been urged that the Miller-Casella Thermometer simply registered the coldest temperature passed through, without regard to depth, Messrs. Negretti and Zambra, scientific instrument makers, devised an apparatus by means of which the temperature can be readily ascertained at any depth as required, and if necessary a series of temperatures could be obtained by fixing these Thermometers on the sounding-line at such intervals apart as may be determined. Figure 1 represents the Thermometer in the position it occupies during descent, and Fig. 2 as it appears after registering. The fan revolves only as the line is drawn up, and attached to it is a screw which permits the Thermometer to turn over in its frame, after the fan has performed a certain number of revolutions, and the column of mercury previously above the bulb indicates the precise Temperature at the time of turning over.

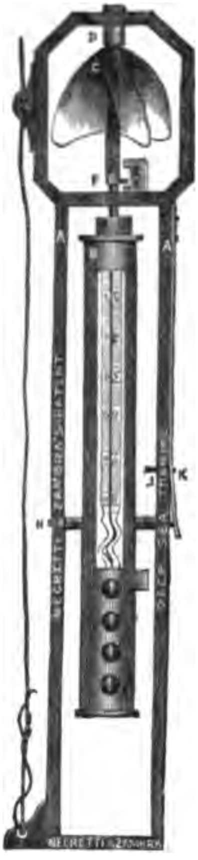

Fig. 1.

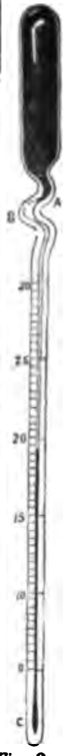

Fig. 3.

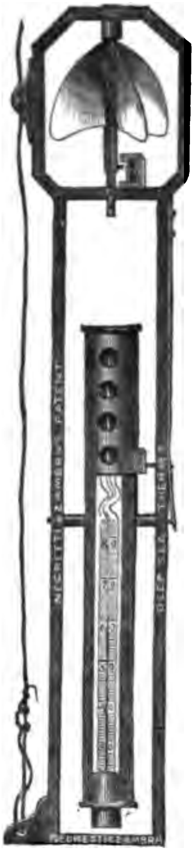

Fig. 2.

The cylindrical bulb (Fig. 3), containing mercury, has its neck closely contracted at A. When the bulb is downward, it contains sufficient mercury to fill the tube and part of the small reservoir C at the other end of the tube. When the bulb is held upward, the mercury breaks off at A, and fills C and a part of the tube, the mercury indicating the temperature on the scale, as shown in Fig. 3. A simpler form of instrument is constructed for ordinary ship's use.

Sir William Siemens' Electric Thermometer is a very delicate instrument, by which the Temperature is recorded on deck at any depth desired. We cannot attempt to describe this, it being only suitable for scientific purposes.

The following illustration has appeared in many previous editions of this work, and, although the instrument is old-fashioned, its principle is good for small depth observations, such as those required by fishermen.

Captain Livingston says:—"In my thermometric experiments I had several thermometers broken. However, to secure my thermometers from being broken, and to enable me to have a column of water round the thermometer sufficient to retain its original temperature till such time as the degree indicated by the thermometer scale could be read off, keeping at the same time the bulb of the thermometer immersed in the water, I prevailed on an ingenious mechanic to attempt the structure of such a case as I wanted, in which he most happily succeeded." The person here alluded to was Mr. Robert Jamieson, of Glasgow, who was honoured with the large silver medal of the Society for the Encouragement of Arts.

Fig. 1, hereto annexed, represents a back view of the case, ready for use, being a tube of copper, which encloses a thermometer; Figure 2 represents a thermometer, so enclosed. The length of the whole tube, including the lid, is about 18 inches, and its external diameter 2 inches. The lid, which has a check to fit the tube, is about 2 inches deep, and has a conical or puppet-valve in it, which rises upward. At the lower end of the tube is another valve of the same description, which also rises upward. These two valves permit the water to pass freely through the tube while it descends into the water; but so soon as it stops, the valves shut, and the water, admitted at the greatest depth to which the machine is sunk, remains in the tube, around the thermometer.

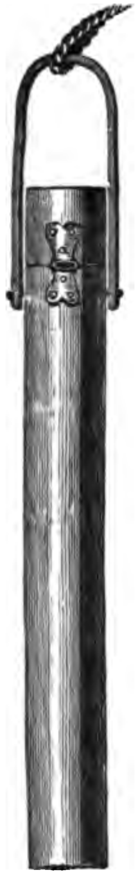

Fig. 1.

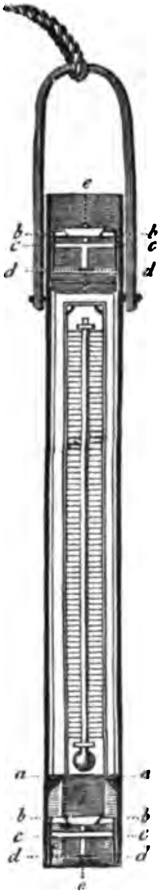

Fig. 2.

Fig. 1 is a back view of the case ready for use. In Fig. 2, *a a* represent a ring, or collar, on which the thermometer-plate rests, to keep it clear of the lower valve; *b b*, the upper valve and valve-tube cover; *c c*, a bridge on which the neck rod, or journal, of the valve works, through a hole in a swell in the centre of the bridge; *d d*, lower part of the journal, with a screw-head, which keeps it from rising through the hole in the bridge; *e e*, ends of the journals.

In recording the Surface Temperature, care should be taken that the instrument is not affected by the hot water from the condenser, or other causes. If the water be drawn up, time should be given for the receptacle to acquire the same temperature as the sea, and the Thermometer must be read immediately it is taken from the water.

The variations of heat and cold, due to change of season, or to day and night, which affect the surface, descend to a comparatively small depth, being greatly reduced in the first 100 fathoms, and below that depth are for the most part eliminated.

The Sun's direct influence probably does not extend below 150 fathoms; below this is a band of 300 to 400 fathoms, in which the temperature falls rapidly to about 38°, and thence to the bottom, which is near 32°, except in inland seas and oceanic basins. Mr. Agassiz says:—"The great cold of the bottom-water of the Ocean, is best brought home to those who have examined the contents of a trawl under the Tropics. The bottom ooze is intensely cold, and it is a strange sensation, while one's back is broiling beneath a Tropical sun, to have one's hands nearly frozen while assorting the contents of the trawl."

Surface Temperature.—Speaking roughly, the Mean Annual Surface Temperature of the water of the Atlantic Ocean, is about 75° F. at the Equator (between 10° N. and 10° S.). Between 10° N. and 38° N. it is 70°. Northward of 38° N., the *Summer* Isotherms (lines passing through places of equal mean temperatures) of 54½°, 50°, and 45½°, turn sharply northwards to the East of the Banks of Newfoundland; diverging one from another, and from the summer Isotherm of 60°, at intervals which are pretty nearly equal, almost as far to the East as the meridian of 30° W.; but then again trending strongly to the North, so that the summer Isotherm of 54½° crosses the parallel of 60° N. before (by a slight trend to the South) it passes through Pentland Firth. Thence, crossing the North Sea, this Isotherm passes along the coast of Norway as far as Tromsö (very near the parallel of 70°), and then turns southwards along the land, keeping within the coast-line of Russian Lapland, and passing across the narrow throat of the White Sea.

The summer Isotherms of 50° and 45½° cross the mouth of Baffin's Bay, and then follow the curve of the coast of Greenland towards Iceland; when approaching which they turn eastwards, the line of 50° striking the land on the N.W. of Iceland, while the line of 45½° passes altogether to the North of the island. To the East of Iceland the Isotherms take a southerly bend, apparently under the influence of a drift of ice from the Polar Sea, but soon turn northwards again; the line of 50° running nearly parallel to the coast of Norway as far as the North Cape, and then turning southwards along the coast of Russian Lapland, so as to cross the mouth of the White Sea to the base of the Kanin Peninsula; while the line of 45½° runs parallel to this as far North as lat. 72½°, and then turns southwards, still retaining the same parallelism, so as to strike the coast of Russia beyond that peninsula. Still farther North we find the summer Isotherms of 41° and 36½° showing a nearly West to East direction, until they have passed the meridian of 10° W., and then suddenly turning northwards; the line of 36½° passing up to the West of Spitzbergen as far as 82° N., and also extending itself irregularly eastwards along the parallel of 75° as far as Nova Zembla.

The course of the *Winter* Isotherms of 45½°, 41°, 36½°, and 32°, as shown in Dr. Petermann's chart, is no less significant; for they all turn sharply to the North on the eastern side of the Banks of Newfoundland, cross the entrance of Baffin's Bay, and then keep a course of general parallelism to the coast of Greenland, crossing the meridian of 30° W. at almost equal intervals. The Winter Isotherm of 45½° follows almost exactly the course of the Summer Isotherm of 54½° as far as the Shetland Islands; but it then turns back on itself so as to form a loop, passing southwards along the Western Hebrides towards Belfast. The course of the Winter Isotherm of 40°, in like manner, at first bears a general correspondence with that of the Summer Isotherm of 50°, skirting the South coast of Iceland, and then passing N.E. in the channel between Iceland and Norway; but in lat. 67½° *it* also returns in a loop, which brings it back to the *East* coast of Scotland. The Winter Isotherm of 36½°, again, corresponds very closely with the Summer Isotherm of 45°; passing through Iceland, and then keeping a N.E. course which carries it far to the North and East of the North Cape, when it, too, forms a loop, bringing it back to the coast of Russian Lapland. Finally, the Winter Isotherm of 32° proceeds along a similar course from the Banks of Newfoundland to the northernmost point of Iceland, and then onwards towards Jan Mayen.

In the above, it will be remarked that the Surface Temperature, North of 40° N., is much greater on the eastern than on the western side of the Atlantic, both in summer and winter; this is due in a great measure to the prevalent south-westerly winds, blowing the warmer water in a north-easterly direction, and also, as will be hereafter explained, to the general oceanic circulation.

It is beyond the scope of this work to enter more into detail as to the power of the various Surface Currents in distributing heat over the Ocean; but that this heated water does not extend to any great depth will be understood from the following remarks on Sub-surface Temperatures. We must also refer the reader to the earlier portion of this book, where, in the description of the Currents, especially of the Gulf Stream, some particulars of the depth to which their warm water extends is generally given.

Sub-surface Temperature.—Taking a general view, or mean for the year, of the water in mid-Atlantic, in a section taken nearly North and South, we find the Temperatures (Fahr.) as follow :—

	60° N.	55° N.	47° N.	38° N.	22° N.	Equator.	20° S.	38° S.
	°	°	°	°	°	°	°	°
At the Surface	50	57	63	70	70	75	70	54
,, 50 fathoms	50	56	62	65	70	75	69	53
,, 100 ,, ...	49	53	55	64	69	70	65	52
,, 200 ,, ...	48	50	51	52	55	48	45	45
,, 500 ,, ...	45	46	47	45	44	39	38	37
,, 1000 ,, ...	40	38	38	37	38	38	36	36
,, 2000 ,, ...	...	37	36	36	35	34	33	34
Bottom	...	...	...	35	35	32	33	33
Depth of bottom	800 fms.	1500 fms.	2000 fms.	2700 fms.	2700 fms.	2500 fms.	2200 fms.	2200 fms.

It may now be confidently stated as a general fact, (1) that over not only the Temperate but also the inter-Tropical portions of the oceanic area, a bottom-temperature prevails of between 32° and 35½° Fahr.; whilst within the Polar areas this temperature falls to 28°. Further, it may be asserted, (2) that this vast oceanic basin, whose average depth may be estimated at about *two miles and a half*, is occupied to within 400 fathoms of its surface (save in the exceptional case of the Gulf Stream region), by water whose temperature is below 40° F.,—this cold water actually coming up nearer to the surface in the Equatorial Atlantic (as several of the older observers had noticed) than it does beneath the Tropics.

Were the bottom of the Atlantic Ocean a perfect basin, the bottom-temperatures might continue the same across its whole breadth, but, as shown in the diagram, the Atlantic sea-bed is divided by ridges into several basins. Now, it has been found that, however deep a basin or depression of the sea-bed may be, yet that the temperature of its water at the bottom will not be less than that which can pass across its ridge, from outside sources. This was observed by Captain Chimmo in the Sulu Sea, a striking example, where at and below a depth of about 300 fathoms (the depth of the enclosing barrier) to the bottom, at 1,778 fathoms, the temperature remained uniform at about 50° F.; whereas, in the China Sea, the flow of cold water from the Polar to the Equatorial regions reduced the temperature, at a depth of 416 fathoms, to 41°, and at the bottom (1,546 fathoms) to 37° F., 13° less temperature than at the *deeper* station of the Sulu Sea.

The same system holds good in such large areas of depressed sea-bed as those in the North Atlantic Ocean, and it has been found that the bottom temperature is never below 35·3° F. in the eastern basin, however deep the water may be; nor below 34·6° F. in the north-western. The only place on the Atlantic sea-bed where the water has been found below 32° (freezing point of fresh water), in the Temperate or Tropical regions, is in the depression between the coast of South America and the central ridge to the South of the Equator.

In conclusion, it may be remarked, that these deep-sea temperature soundings are of great practical utility to telegraph engineers, and they will be alluded to presently as affecting the question of Circulation.

Salinity and Specific Gravity.—It is considered that the salt contained in sea-water is mainly derived from the land, the rain and springs dissolving substances from the surface and lower strata, which are carried down to the sea by the streams and rivers. In regard to this subject, we cannot do better than give first a few extracts from a very interesting essay, laid before the Royal Society, by Professor George Forchhammer, of the University, and Director of the Polytechnic Institute, at Copenhagen.*

"The elements which occur in the greatest quantity in sea-water have been long known, and the latest enquiries, my own included, have brought the number of them up to twenty-seven, which are as follow:—1, oxygen; 2, hydrogen; 3, chlorine; 4, bromine; 5, iodine; 6, fluorine; 7, sulphur;

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* "On the Composition of Sea-water in different parts of the Ocean," in the "Philosophical Transactions of the Royal Society," 1865, pages 203—262.

8, phosphorus; 9, nitrogen; 10, carbon; 11, silicium; 12, boron; 13, silver; 14, copper; 15, lead; 16, zinc; 17, cobalt; 18, nickel; 19, iron; 20, manganese; 21, aluminium; 22, magnesium; 23, calcium; 24, strontium; 25, baryta; 26, sodium; 27, potassium.

"The substances which, in respect of quantity, play the principal part in the constitution of sea-water, are chlorine, sulphuric acid, soda, potash, lime, and magnesia; those which occur in less but still determinable quantity, are silica, phosphoric acid, carbonic acid, and oxide of iron. All the numerous other elements occur in so small a proportion, that they have no influence whatever on the analytical determination of the salinity of sea-water.

"The next question to be considered refers to the proportion between all the salts together and the water; or, to express it in one word, the *salinity* of the sea-water; and in connection with this salinity or strength, the proportion of the different solid constituent parts among themselves. On comparing the older chemical analyses of sea-water, we should be led to suppose that the water in the different seas had, besides its salinity, its own peculiar character, expressed by the different proportions of its most prevalent acids and bases, but the following researches will show that this difference is very trifling in the Ocean, and has a more decided character only near the shores, in the bays of the sea, and at the mouths of great rivers, wherever the influence of the land is prevailing.

"I have always calculated the single substances, and the whole quantity of salt, for 1,000 parts of sea-water; but, besides this, I have calculated the proportion between the different substances determined, referred to chlorine = 100, and of all the salts likewise referred to chlorine. This last number is found, if we divide the sum of all the salts found in 1,000 parts of any sea-water, by the quantity of chlorine found in it, and I call it the *co-efficient* of that sample of sea-water. There is a very small difference in the co-efficients of the different parts of the Ocean, but the differences become striking in the neighbourhood of the shores."

Without going into the details given by Professor Forchhammer, we extract the following as the general results of his investigations:—

"If we except the North Sea, the Kattegat, Sound, and Baltic, the Mediterranean and Black Seas, the Caribbean Sea, and the Red Sea, which have all the characters of bays of the great Ocean, the mean numbers are the following:—

Sea-water.	Chlorine.	Sulphuric acid.	Lime.	Magnesia.	All salts.	Co-efficient.
1.000	18.999	2.258	0.556	2.096	34.404	1.812
	100	11.88	2.93	11.03		
Equivalents	429	45	16	82		

"Thus it is evident that sea-water in its totality is as little a chemical compound as the atmospheric air; that it is composed of solutions of different chemical compounds; that it is neutral, because it everywhere in the atmosphere finds carbonic acid to neutralize its bases, and everywhere on its bottom and shores finds carbonate of lime to neutralize any prevailing strong acid; that, lastly, the great stability of its composition depends upon its enormous mass and its constant motion, which occasions that any local variation is evanescent compared to the whole quantity of salt.

"If we take the mean numbers for the five regions of the Atlantic between the southernmost point of Greenland and that of South America, we find the mean quantity of salt for the whole Atlantic 35·833, while the sea between Africa and the East Indies has only 33·850; the sea between the East Indies and the Aleutian Islands, 33·569; and the South Sea, between the Aleutian Islands and the Society Islands, 35·219 per 1,000 salt. The Atlantic is thus that part of the Ocean which contains the greatest proportion of salt, which result is rather surprising, if we consider the vast quantity of fresh water which the rivers of Africa, America, and Europe pour into it; of Africa, four-fifths are drained into the Atlantic, either directly or through the Mediterranean; most probably nine-tenths of America is drained into the Atlantic, since the Cordilleras run close to the western shore of the continent; and of Europe, also, about nine-tenths of its surface sends its superfluous water to the Atlantic. This greater quantity of fresh water from the land, and the greater quantities of salts in the corresponding sea, seem to contradict each other, but can be explained by a higher temperature, and, as the result of this higher temperature, a greater evaporation.

"Some of the large bays of the Ocean have, in the Tropical or sub-Tropical zones, a greater mean than the Atlantic. Such are the Mediterranean, with 37·936 per 1,000 salt (mean of eleven observations); the Caribbean Sea, with 36·104 per 1,000 (one observation); the Red Sea, 43·067 per 1,000 (mean of two but little differing observations), which is the greatest salinity of the sea I know of.

"In approaching the shores, the sea-water becomes less rich in salts, a fact which finds its explanation in the more or less quantity of fresh water which runs into the sea. On such shores, where only small rivers flow out, the effect produced is but very trifling, as, for instance, on the western shores of South America. The effect of large rivers in diluting the sea-water is much greater than is generally supposed; thus, the effect of the La Plata River, whose mouth lies in about 35° South latitude, was still observable in a sample of sea-water taken in 50° 31′ S., at a distance of 15° of latitude, or 900 English miles, from the mouth of the river; at about the same distance, the water of the North Atlantic suffered a considerable depression in salinity, probably owing to the water of the St. Lawrence. This influence is of a double kind, partly in diluting the sea-water, partly in mixing up with it organic substances that will occasion its decomposition by putrefaction."

Mr. J. Y. Buchanan, from observations made on the cruise of H.M.S. *Challenger*, shows that in the North Atlantic Ocean, the area of maximum surface Salinity, over 37·2 parts per 1,000, forms an ellipsis stretching W.S.W. from the Canary Islands to lat. 22° N., long. 55° W.; but Dr. Krümmel, from his examination of numerous reliable observations,* considers the limits are not so exact, but it appears certain that the maximum lies not far from lat. 25° N., long. 35° W., and that it never exceeds 37·5 parts per 1,000. Northward of lat. 45°, the Salinity does not exceed 36 parts, and in Davis Strait it is 34½ parts per 1,000.

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* "Die Verteilung des Salzgehaltes an der Oberfläche des Nordatlantischen Ozeans," with a Chart, in "Petermann's Mitteilungen," 1890, pages 174—176.

Several forms of apparatus have been devised for securing samples of the water from great and intermediate depths. On the voyage of H.M.S. *Challenger*, samples were collected at various depths in various parts of the world, and Professor Dittmar, from an analysis of 77 specimens, concluded that the average composition of the salts of sea-water is as follows:—Chloride of Sodium, 77·758; Chloride of Magnesium, 10·878; Sulphate of Magnesium, 4·737; Sulphate of Lime, 3·600; Sulphate of Potash, 2·465; Bromide of Magnesium, 0·216; and Carbonate of Lime, 0·345.

The *Specific Gravity* of ocean water, free from land and other influences, varies within very narrow limits, 1·024 and 1·028 at 60° F., or 15·56° Cent. In the regions of great rainfall near the Equator, the surface is frequently quite fresh; and in the Temperate zone there is nearly an equilibrium between the rain and evaporation. To these sub-divisions of concentration and precipitation is assigned an important part in the formation of Ocean Currents.

The following is also by Mr. J. Y. Buchanan, M.A. (the chemist of the *Challenger* expedition), from a paper read before the Royal Geographical Society in 1877:—

The Specific Gravity* of the surface water was determined (at a temperature of 39° F.), every day when at sea, and from the bottom and intermediate depths as often as opportunity offered.

As far as the surface is concerned, the general results were as follows. The concentration of the waters of the Atlantic Ocean is greater than that of either the Pacific or the Southern Ocean, and it is greater in the North Atlantic than in the South Atlantic, although the actual maximum may be slightly higher in the South Atlantic. In the North Atlantic, the maximum (1.0275) was observed in lat. 22° N., long. 40° W., from which point it diminishes in all directions. (On the South Coast of Iceland it was 1.0260).

If we consider the water below the surface, as shown in the vertical sections, we find, in the Atlantic, that in the concentration-areas the Specific Gravity diminishes until a minimum (1.0260) is reached at a depth of about 800 or 1,000 fathoms, after which it increases slightly down to the bottom. In investigating the causes of the variations in the Specific Gravity of the Ocean, we find that they depend on the means available for removing or supplying *water*. Thus, the areas of greatest concentration coincide with those where the dry Trade Winds are constantly blowing, taking their rise in the lower Temperate latitudes, and proceeding in their course always from colder to warmer regions, so that, for the first part of their journey, at least, although they are continually taking up moisture, their capacity

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* According to Erman's elaborate investigations, the weight of salt in 1,000 parts of sea-water, of different specific gravities, is—

Specific Gravity	1.025	1.026	1.027	1.028
Salts per 1,000	33.765	35.049	36.343	37.637

for doing so is continually increasing. Hence the great concentration of the water in the steady Trades of the Atlantic.

The observations make it probable that in the Atlantic the water from the surface, down to a depth of 1,000 fathoms, has, on the whole, a flow *inwards*, or from South to North, and below that depth and down to the bottom it appears to have an opposite flow, thus providing for the removal of the salt which otherwise would accumulate in the North Atlantic. The Atlantic thus presents, on a larger scale, what is observed in the Mediterranean, where the mean drying power of the atmosphere is higher than even in the North Atlantic. In the Pacific, owing to its form and general climate, these conditions are not so evident.

The Gulf Stream (or rather the edge of it, where its warm and dense water met the "cold wall" of the Labrador Current), was very clearly indicated simply by the Specific Gravity. The Equatorial Currents, also, were very marked. The Agulhas Current of South Africa showed similar variations in density.

CIRCULATION of the OCEAN.—That there is a circulation and intermingling of all the Ocean waters is shown in (246), page 297. Of the means by which this interchange is produced, numerous theories have been advanced, as alluded to in (248), page 298, and in (362) and (363), pages 377—379. It is only in recent years that any really reliable *data* have existed to elucidate the subject, and, at the present time, physicists are pretty well agreed that the great cause of the circulation of the water is its varying Specific Gravity. This Specific Gravity, or Density, is regulated chiefly by Temperature, but also by the amount of salt contained in the water. Without going into further details, the simple theory, which recent investigations have strengthened, is that a cold under-flow of water is continually kept up from the Polar to the Equatorial regions.*

This theory Professor Lenz, of St. Petersburg, advanced as *an inevitable deduction* from the facts ascertained by the remarkable series of observations on the Temperature and Specific Gravity of Oceanic Water at various depths, which he had made in the second voyage of Kotzebue, during the years 1823—1826. He drew from these results the very conclusions which derived remarkable confirmation from the Temperature soundings and Specific Gravity observations of H.M.S. *Challenger*, viz.:—1. The doctrine of a deep under-flow of glacial water from each Pole to the Equator. 2. The ascent of Polar water towards the surface under the Equator, as evidenced by the rise of the bathymetrical Isotherms, by the keeping down of the Surface Temperature, and by the low (Polar) Salinity of Equatorial surface water. 3. The movement of the upper stratum of oceanic water from the Equatorial region towards each Pole, as the necessary complement of the deep Polar under-flow. 4. The dependence of this double movement upon the disturbance of hydrostatic equilibrium constantly maintained by Polar cold and Equatorial heat. The opposition which has been raised to this doctrine of a thermal circulation has mainly rested on one or both of two pre-conceptions:—1. The origination of all oceanic movements in the surface-action of Wind. 2. The sufficiency of the Gulf Stream to produce the amelioration of the climate of north-western Europe.

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* That *under-currents* do actually exist is well-known (see pages 407—409). H.M.S. *Challenger* several times tested the rate and direction of the under-current by means of a wooden framework, covered with canvas, lowered by a rope to the depth at which the current was to be tested; the upper end of the rope was attached to a buoy which floated on the surface, and, after allowing for the effect of the surface-current, showed by its progress the direction of the current at the depth where the framework was floating. This same process was used by Dr. Carpenter, in testing the flow of cold water from the Atlantic into the Mediterranean through the Straits of Gibraltar. In recent years, the telegraph steamers have found evidences of strong currents at a depth of 1,000 fathoms between the Canary Islands. It is, of course, possible that under-currents may in places be so near the surface as to affect the course of a ship deep in the water.

Sir Wyville Thomson makes the following remarks on this subject:*—

"All the facts of Temperature distribution in the Atlantic appear to favour the view that the entire mass of Atlantic water is supplied by an indraught from the Southern Sea, moving slowly northward, and interrupted at different heights by the continuous barriers which limit its different basins; but this involves the remarkable phenomenon of a vast body of water constantly flowing into a *cul de sac* from which there is no exit. When I suggested this view some years ago, I was asked, very naturally, how it was possible that more water could flow into the Atlantic than flowed out of it, and at that time I could see no answer to the question, although I felt sure that a solution must come some day. Now it seems simple enough; but in order to understand the conditions fully, I would ask my readers to recall the appearance of the Atlantic, and of the Pacific also, which is under exactly the same conditions. On the globe one sees much more clearly than on a map that the Atlantic is a mere tongue, as it were, of the great ocean of the water hemisphere stretching up into the land. The Arctic Ocean, with which it is in connection, is again a very limited sea, and nearly landlocked. The North Pacific is another gulf from this 'water-hemisphere,' but one vastly wider and of greater extent; while the South Pacific is included within the 'water hemisphere.'

"Although from the meridional extension of the continents to the southward, the water of the Atlantic is, as I have shown, directly continuous, layer for layer, with the water of the Antarctic basin, it must be looked upon not as being in connection with that basin only, but as being a portion of the great ocean of the water-hemisphere; and over the central part of the water-hemisphere, precipitation is certainly greatly in excess of evaporation, while the reverse is the case in its extensions to the northward. The water is therefore carried off by evaporation from the northern portions of the Atlantic and of the Pacific, and this vapour is hurried down towards the great zone of low barometric pressure in the southern hemisphere; the heavy, cold water welling up from the southward into the deepest parts of the northward extending troughs, to which it has free access, to replace it. It is unfortunate that we have, as yet, scarcely sufficient data to estimate the relative amount of rain and snow in the northern and southern hemispheres, but the broad fact that there is very much more in the southern is so patent as scarcely to require proof. This excess becomes still more apparent when we include, as we must do, in this source of supply of water to the North, the Tropical region of the South Pacific, which forms part of the great ocean."

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* "Voyage of the *Challenger*; the Atlantic," vol. ii., pages 324—326.

Mr. W. L. Jordan[*] argues against the usually accepted theory of Ocean Circulation, contending that the forces of gravitation constantly draw the ocean water not only eastwards, but also *downwards*, throughout both of the Temperate zones, and *upwards* at the Poles and along the Equator. He held that the Temperature soundings of H.M.S. *Challenger* proved his view correct, showing that, instead of the Temperature uniformly decreasing as the depth increased, the *Challenger* records point to the existence of bands of water, at great depths, of a temperature intermediate between both colder and warmer water above them, and this in such a manner that the observations elaborately check each other. In his letter of November 8th, 1887, to the Lords of the Admiralty, he draws attention to the assumed errors in the thermometer indications, in the following words:—"The *Challenger* staff appear, indeed, to have shut their eyes to the grandest result of their own explorations, and, after the return of the expedition, they not only with one consent avoided my attempts to discuss the results with them, but also for eight years suppressed many of the records which most strongly supported my side of the controversy.

"Not only have the *Challenger* staff endeavoured to make the deep water, one, two, three, and even four miles below the surface of the ocean, conform itself to the Temperature which their preconceived ideas required, but they have also endeavoured to make the surface-water move in accordance with what their preconceived idea of the action of the Winds requires, as is apparent from the erroneous method of ascertaining the surface-currents."

ANIMAL LIFE, Etc.—"The curious on board ship sometimes amuse themselves by letting overboard, in light winds and calms, a hoop-net of gauze, or other light material, to 'catch insects of the sea;' crumbs of bread or other food that will attract them are sometimes placed in it as bait. The hoop is to keep the mouth of the net open, and prevent it from collapsing into folds and crushing its spoils as it is hauled up; and these, when they are received on deck, are regarded by all on board with amazed interest and curiosity.

"But wait until the microscopist mounts them on his slides, and brings the powers of his instrument to bear. Then every one who looks marvels at the beauty and variety of organic form there presented, and the beholder is at once struck with the extent, resources, and the richness of the new field of research, into which he has now, it may be for the first time, had the opportunity of casting a look. He fully realizes the idea that the organisms of the sea are as multitudinous as its waves, and as marvellous as its wonders.

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[*] "The Admiralty Falsification of the *Challenger* Record Exposed," by W. L. Jordan, F.R.G.S., 1890.

"With such a subject for study and contemplation as these insects afford to all who use the microscope, let no naturalist who crosses the ocean, and no passenger on board ship, or mariner, who can afford to purchase a microscope, talk hereafter about the monotony of a sea voyage, or the *ennui* of a passage. More varied, strange, and new than the insect life of *terra firma*, the entomology of the sea, if we may so style the families of its little crustaceæ, medusæ, and zoophytes, offers quite as profitable and as instructive a field of investigation as does the entomology of the air.

"The floating crustaceæ of the high seas are classed by naturalists a little lower than the insects of the air, yet, in the scale of being, they rank higher than the worms of the earth. Every one who, with an eye for the microscope, goes to sea, may help, with proper drawings and descriptions of what comes to his net, greatly to enrich this field. Not only so, these mites of moving creatures will tell us in their mute way, if we consult them aright, of all the Currents, Polar and Equatorial, that help to regulate the climates of the great deep. They may be regarded as tallies to the water by which the system and channels of Oceanic Circulation are to be pointed out and made visible, as it were, to the eye of science."—*Captain Maury.*

This "*New Field,*" as it was termed by Maury, can be readily explored by any one who will take the trouble to do so. A simple contrivance, if a microscope is not at hand, will afford the means. The eye-piece, or first joint of an ordinary telescope, is a very good substitute. To use it for the transparent objects, of which the minute inhabitants of the surface waters generally consist, place them in a drop of water on a piece of glass, held or fixed horizontally a few inches above a sheet of white paper or a looking-glass, and the telescope joint held by the lower part at from a quarter to half an inch above the surface of this glass, will make an excellent microscopic tube of great power, sufficient to show many of the singular forms and great beauties of the animalcules, which can be easily collected in vast numbers.

The best or readiest way of obtaining them is to tow a small net, consisting of a hoop from one to three feet in diameter, on which is strained a piece of bunting or fine gauze, and this being drained occasionally into a vessel, will afford an abundant harvest. Floating weeds also contain great quantities of minute living creatures, which may be taken by the same means. In a stationary vessel, large numbers of these creatures accumulate on the lee-side.

It would be entirely beyond the province of this work to deal with the characteristics and families of these inhabitants of the seas, although much good may be done, hydrographically, by the study of their distribution. This subject must be pursued in other works, such as those enumerated on page 916.

The surface water of the open Ocean generally teems with microscopic animal and vegetable life, but the distribution may vary in quantity. The German "Plankton" Expedition, sent out in 1889 specially to study the surface waters of the North Atlantic Ocean, found the *Sargasso Sea* to be surprisingly poor in animal life, but the transparency of its water is truly remarkable, a white canvas disc being visible at a depth of 37 fathoms.

From recent investigations, it is found that sponges, corals, crustaceæ, and molluscs are obtained from all depths, some soft-bodied creatures even from a depth of 4 miles, where the pressure would be four tons on the square inch. The eyes of deep-sea animals are very rudimentary, but many are provided with sensitive delicate feelers. The "Plankton" Expedition found that the number of organisms living in great depths is very much less than in the upper strata, which are penetrated by the light; not only the quantity diminishes, but also the number of species. A species of vesicular marine *algæ* was found in large quantities, at depths from 500 to 1,100 fathoms; the *Challenger* scientists concluded that all vegetable life ceased at 200 fathoms.

The *Challenger* trawls brought up fish from depths of 2,900, 2,750, 2,650, and 2,500 fathoms; the *Albatross* brought up similar fish from 2,949 fathoms; and the *Talisman* from 2,200 fathoms. Prof. Agassiz remarks that "in fishes brought up from deep water, the swimming bladder often protrudes from the mouth, the eyes are forced out of their sockets, the scales have fallen off, and they present a most disreputable appearance," all owing to the loss of pressure.

In 1881, the French exploring vessel *Travailleur*, when off the coast of Portugal, in depths of 800 to 1,000 fathoms, secured specimens of a large fish of the shark family, which appear never to come to the surface. The Portuguese fishermen also take such fish from a depth of 500 fathoms.

In the deep sea, Dr. Carpenter remarks that animal life "is so intimately related to the temperature of the bottom, as obviously to be determined by that condition in a much greater degree than by its depth. This was very strongly impressed on Sir Wyville Thomson and myself in our early investigations. For in the deep trough lying N.E. and S.W., between Shetland and the Færoe Islands, which, having been our cruising ground in 1868, I have ventured to call the *Lightning Channel*, we found at corresponding depths of between 500 and 600 fathoms, and sometimes within a few miles of each other, two areas whose temperatures differed by more than 13° Fahr.; the bottom temperature of the 'warm area' being about 43°, while that of the 'cold area' was somewhat below 30°. The Fauna of these two areas showed the most marked diversities. I was thus led, in my report for 1869, to express my entire concurrence in the speculation thrown out some years previously by Professor Lovén, that 'there exists in the great Atlantic depressions, perhaps in all the abysses of our globe, and continued from Pole to Pole, a fauna of the same general character, thriving under severe conditions, and approaching the surface where none but such exist,—in the coldest seas.'*

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* "Proceedings of the Royal Society," 1869, page 475. The similarity of Antarctic to Arctic forms of marine life had, indeed, been previously noticed by Sir James Ross; and had been attributed by him to the prevalence of a "similar temperature" over the whole of the intervening sea-bed. This temperature, however, he erroneously supposed to be 39·5° Fahr.

"This expectation was most remarkably confirmed by the *Challenger* researches; one of the most important of the general results of that expedition being the recognition of an abyssal Fauna, essentially the same, over the whole oceanic area that is reached by the glacial underflow, without any relation whatever to the terrestrial climate of the locality, and scarcely showing any difference according to its Arctic or Antarctic derivation. Thus we see that, even at the present time, the essential conditions of a "glacial epoch" prevail upon the Deep-Sea bed from each Pole to the Equator; so that the presence of Arctic types of animal life in any *marine* deposit of Temperate or even Tropical zones, affords not the least evidence, *per se*, of the former extension of glacial action over the *land* of these localities."

Sir Wyville Thomson remarks:*—"The most prominent and remarkable biological result of the most recent investigations is the final establishment of the fact that the distribution of living beings has no depth limit; but that animals of all the marine invertebrate classes, and probably fishes also, exist over the whole of the floor of the ocean. My present impression is, that, although life is thus universally extended, the number of species and of individuals diminishes after a certain depth is reached, and that at the same time their size usually decreases.

"Using all precautions and with ample power and the most complete appliances,† it is extremely difficult to work either with the Dredge or with the Trawl at depths approaching or exceeding 3,000 fathoms. A single dredging operation in such depths takes a long time; the Dredge is put over at daybreak (the ship being kept as nearly as possible stationary), and it is usually dark before it is recovered, so that the number of such operations must be comparatively small. We must therefore bear in mind that only an infinitesimally small portion of the floor of the Ocean, at depths over 2,500 fathoms, has yet been explored.

"As we had previously anticipated, the Fauna at great depths was found to be remarkably uniform. Species nearly allied to those found in shallow water, of many familiar genera, were taken in the deepest hauls, so it would seem that the enormous pressure, the utter darkness, and the differences in the chemical and physical conditions of the water, and in the proportions of its contained gases depending upon such extreme conditions, do not influence animal life to any great extent.

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* "Voyage of the *Challenger;* the Atlantic," vol. ii.

† In the examination of the Animal Life, three forms of apparatus were used by H.M.S. *Challenger*. 1. A *Dredge*, consisting of a dredge-bag attached to an iron frame 4½ ft. long by 1½ ft. broad. To the bottom of the frame was attached a bar, bearing *tangles* of rope-yarn, in order to entrap various animals while passing over the bottom. The dredge-bag usually came up from the bottom, at great depths, full of mud (*globigerina ooze, &c.*), but on one occasion a huge block of syenite was brought up in the mouth of the dredge from a depth of 1,340 fathoms, about 150 miles southward of Cape Sable in the North Atlantic. 2. The *Deep-Sea Trawl*, a conical bag 30 ft. in length, weighted at its bottom end, and suspended by one side of its mouth to a beam of wood; the other side of the mouth, which drags along the sea-bottom, hangs loose, and in order that the bag may keep open is weighted with some pieces of lead. The mouth of the Trawl-bag is fitted with a netted funnel arrangement which prevents the escape of animals after capture. 3. An *ordinary Trawl-net*, kept open at its mouth by an iron ring, was dragged behind the vessel at small depths. The accumulators (page 923), to which the dredge-ropes were attached, were slung from the mainyard-arm, and the hauling in of the dredges was effected by a donkey-engine.

"The geographical extension of any animal species, whether on land or in the sea, appears to depend mainly upon the maintenance of a tolerably uniform temperature, and the presence of an adequate supply of suitable food.

"There is every reason to believe that the Fauna of deep water is confined principally to two belts, one at and near the surface, and the other on and near the bottom; leaving an intermediate zone, in which the larger animal forms, vertibrate and invertibrate, are nearly or entirely absent."

Mr. J. J. Wild remarks, notwithstanding the number of miles of sea-bottom passed over by the *Challenger's* dredges, that, with the exception of a few sharks' teeth and some ear-bones of whales, no trace of the more highly organised animals was brought to the surface. No human bones, no portion of a ship or any other article of human manufacture, were ever raised from the deep sea.

The Sea Serpent.—The belief in the Sea Serpent dates from very early times, but there is no authentic case of the capture of such a creature, or of the finding of its remains. Several cases of its appearance have been so strongly testified, that it is difficult to disbelieve the existence of some gigantic species of the eel and octopus or cuttle-fish; certainly, the wide ocean affords plenty of room for the accommodation of such creatures. Doubtless, in many cases, observers have been misled by appearances due to sharks or porpoises swimming in line, or to swarms of sea-fowl, and long lines of seaweed.

Mr. Gosse, in his "Romance of Natural History," carefully collected numerous accounts of the Sea Serpent, and by classifying them found the average description is that of a large serpent, 60 ft. long, with a flat head, neck 12 to 16 inches in diameter, with a kind of mane, body of a dark colour, but lighter on the under surface, swimming with its head slightly elevated, and spouting water.

WAVES.—The Waves of the Ocean, like other undulating bodies, move onward, but the water of which they are formed is constantly being changed, as will be readily seen from the movements of any light floating object, which does not keep pace with the wave motion, but is left behind. Many interesting observations have been made upon the dimensions of ocean Waves, but the results of different observers naturally differ widely, as the surface of the sea is rarely traversed by long unbroken lines of Waves, and usually assumes the appearance of a succession of billows or detached hills of water, making accurate measurements difficult.

In ordinary gales, in deep water, the height of the Waves, from trough to crest, is from 15 to 20 feet. Dr. Scoresby, a careful observer, measured Waves 30 ft. high in the North Atlantic Ocean, and was of opinion that 43 ft. was a maximum height in heavy seas. A height of 36 ft. has been recorded in the Bay of Biscay, and Admiral Fitzroy, on one occasion, estimated some storm Waves to be 70 feet in height. In June, 1875, the steamer *Celtic* was also stated to have encountered Waves 70 ft. high.

The rate of speed of Waves has been estimated at 19 miles an hour when they are 100 ft. apart from crest to crest, 27 miles when 400 ft., 32 miles when 600 ft., and, with a phenomenal distance apart of 2,720 ft., the speed was 72 miles an hour. Dr. Schott (see page 925), in a voyage from Europe to the East, found that a moderate Trade Wind causes Waves from 38 to 44 ft. apart, travelling 17 miles an hour. He found that big storm Waves may be 220 ft. apart, and travel 40 miles an hour; the highest one measured was 32 feet.

The highest Waves are reported as being encountered in the Southern Ocean, off the Cape of Good Hope and Cape Horn, where they sometimes run from 30 to 40 ft. high.

From personal observation, on a voyage from New Zealand round Cape Horn, in June, 1885, in the steamer *Tongariro*, the Hon. R. Abercromby, F.R.M.S., measured Waves from 21 to 46 ft. high, and many reached 30 to 35 ft.; their distance apart varied from 358 to 507 ft., their speed 29 to 47 miles an hour, and the time interval between the crests 14 to 19 seconds.* He gives the following summary:—Several sets of observations between New Zealand and Cape Horn, with an aneroid barometer and a chronograph, gave for the largest Waves a height of 46 ft., a length (or distance apart) of 765 ft., a speed of 47 miles an hour, and a time-period of 16½ seconds. As nothing but the ordinary heavy weather of these latitudes was experienced, it is certain that Waves must sometimes attain a height of at least 60 feet.†

ON THE USE OF OIL FOR CALMING ROUGH SEAS.

The action of Oil in calming heavy seas appears to have been known in the early days of navigation. That it was known to the ancients, is proved by the writings of Pliny (A.D. 23—79), who speaks of it in his "Natural History." The Venerable Bede, too, in his "Ecclesiastical History" (A.D. 716—731), tells of the deliverance of a ship from a stormy sea, through the agency of a pot of Oil, which had been blessed by Bishop Aidan.

Strangely enough, it is only within the last few years, that the great value of greasy compounds, in quieting heavy seas, has come to be fully acknowledged, and the following account has been derived from many sources, but mainly from records appearing on the valuable "Pilot Chart for the North Atlantic Ocean," issued monthly by the United States Hydrographic Office.

The testimony as to the great value of the use of Oil for this purpose is very conclusive, and no vessel should neglect its use in emergencies, such as when heavy seas threaten to break on board. Once tried, its value will never be disputed, and those who are sceptical are urged to give it a fair trial. The experiment can be very easily made, and at small expense, while the results, as reported, have been almost invariably successful. All that seems to be necessary is to rig up any sort of simple apparatus which will ensure a small but steady flow of Oil.

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* "Seas and Skies in Many Latitudes," 1888.

† "Observations on the Height, Length, and Velocity of Ocean Waves," in the "Philosophical Magazine," 1888, pages 263—269.

When Oil is poured on a rough sea, it quickly spreads around and to windward, preventing the waves breaking. Lord Rayleigh, in a lecture before the Royal Institution, 1890, stated that its action may be compared to an inextensible membrane, floating on the surface of the water, and hampering its motion, thus rendering the formation of waves difficult. Of course, in a surf, or on breaking bars or shoals, its action cannot entirely overcome the momentum of the seas, but it exercises a considerable calming effect. Ships' boats should always be provided with a supply of suitable Oil, only a small quantity being necessary, if properly applied, and it might, at times, be very useful in hoisting or lowering boats in a sea. With the wind on the quarter, the effect seems to be less than in other position, as the Oil goes astern while the waves come up on the quarter.

With regard to the best form of Oil for this purpose, it is found that animal and vegetable Oils are most suitable, such as sperm, turpentine, rape, linseed, cotton-seed, castor, almond, and olive. Mineral Oils exert little influence upon rough seas, though crude petroleum has given favourable results; when refined it is not so good. Thick and heavy Oils are the best; but some, such as cocoa-nut oil and some kinds of fish-oil, congeal in cold weather, and are then useless, but they may advantageously be mixed with mineral oil.

From actual use, it has been found that the tendency of petroleum to spread itself over the water is only about one-half that of olive oil, one-third that of linseed oil, one-fourth that of sperm oil, and one-fifth that of soap-suds. *Soap*, dissolved in *fresh* water, seems the best agent for preventing the *growth* of waves, both on account of its superior spreading power and the reduction of the surface-tension that it brings about; but it has the drawback of mixing with the water, instead of forming a coating on the surface. Its action in preventing the *breaking* of heavy seas is also doubtful. Oil of turpentine is the best for spreading, and reducing the tendency of the wind to form waves and increase their size. Some consider porpoise oil very effective, and one observer states that from 1 to 3 gallons, used in a bag of oakum, will run a vessel through a prolonged gale.

Probably the best way to use Oil, is by filling the forward closet-bowls with oakum and Oil, or using a can with a drip-tap, which thus allows it to run slowly out through the waste-pipes. Another simple and good method of distributing it, is by canvas bags about one foot long, filled with oakum and Oil, and pierced with holes by a coarse sail-needle, and held by a lanyard. Another method is to use a small barrel, with a tap and small hose leading down to the water; this can be slung in any desired position.

Rules for Use.—The following rules were drawn up, in 1889, by Captain R. Karlowa, of Hamburg, and will show the best method of using Oil, under various circumstances; the arrows on the diagrams denote the direction of the wind and sea, and the flowing lines represent the spreading of the Oil.

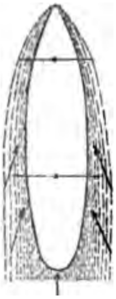

Fig. 1.

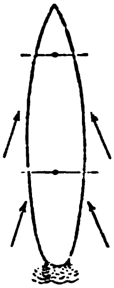

Fig. 2.

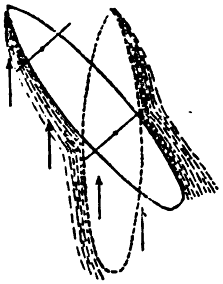

Fig. 3.

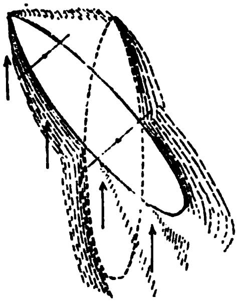

Fig. 4.

Scudding before a Gale (Fig. 1), distribute Oil from the bow by means of oil-bags or through the waste-pipes; it will thus spread aft, and give protection both from quartering and following seas. If only distributed astern (Fig. 2) there will be no protection from the quartering sea.

Running before a Gale, yawing badly and threatening to broach-to (Figs. 3 and 4), Oil should be distributed from the bow and from both sides, abaft the beam. In Fig. 3, for instance, where it is only distributed at the bow, the weather quarter is left unprotected when the ship yaws. In Fig. 4, however, with oil-bags abaft the beam as well as forward, the quarter is protected.

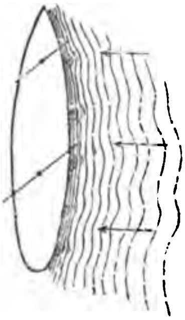

Fig. 5.

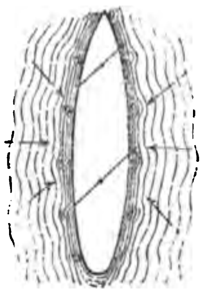

Fig. 6.

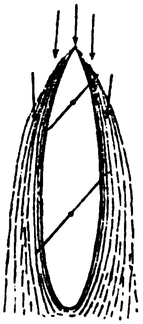

Fig. 7.

Lying-to (Fig. 5), a vessel can be brought closer to the wind by using one or two oil-bags forward, to windward. With a high beam sea, use oil-bags along the weather side at intervals of 40 or 50 feet.

In a heavy cross-sea, (Fig. 6), as in the centre of a Hurricane, or after the centre has passed, oil-bags should be hung out at regular intervals along both sides.

Steaming into a heavy head-sea (Fig. 7), use Oil through the forward closet-pipes. Oil-bags would be tossed back on deck.

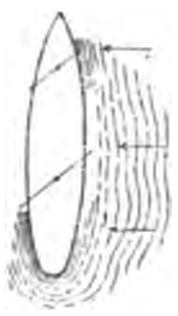

Fig. 8.

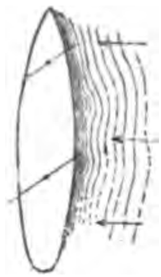

Fig. 9.

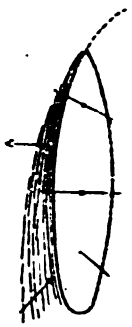

Fig. 10.

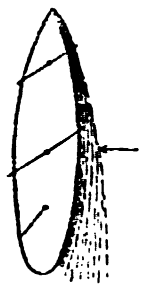

Fig. 11.

Drifting in the trough of a heavy sea (Figs. 8 and 9), use Oil from the waste-pipes forward and bags on weather side, as in Fig. 9. These answer the purpose very much better than one bag at the weather bow and one at the lee quarter, although this has been tried with some success (Fig. 8).

In lying-to (Fig. 10), *to tack or wear*, use Oil from the weather bow.

Cracking on, with high wind abeam and heavy sea (Fig. 11), use Oil from the waste-pipes, on the weather bow.

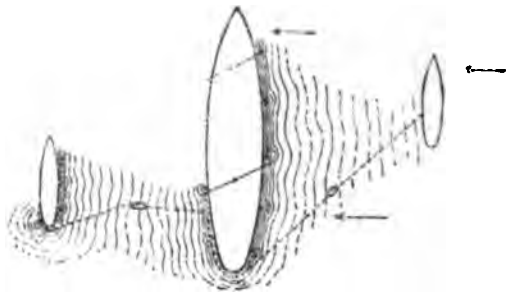

Fig. 12.

A vessel hove-to for a pilot (Fig. 12), should distribute Oil from the weather side and lee quarter. The pilot-vessel runs up to windward and lowers a boat, which pulls down to leeward and around the vessel's stern. The pilot-vessel then runs down to leeward, gets out oil-bags to windward and on her lee quarter, and the boat pulls back around her stern, protected by the Oil. The vessels drift to leeward and leave an oil-slick to windward.

At anchor, in an open roadstead, oil-bags could be slung on the jib-boom, or hauled out ahead to a block secured to the cable.

In towing another vessel, in a heavy sea, Oil is of the greatest value, and should be distributed forward and on both sides of the vessel towing.

When a boat is riding to a sea-anchor, the bag can be hauled out and in by means of a line to a block on the anchor.

We could give hundreds of examples showing the great value of Oil in cases of emergency, but can only quote a few here. There can be no shadow of doubt but that many ships are now afloat, which would have ended their careers and never been heard of, had it not been for the beneficent influence of Oil on troubled waters.

Capt. Freeman, of the steamer *Karoon*, states:—" As to the use of Oil, I must at once confess that I had heard it talked about, but did not at any time believe it to be of any use, solely because I had not seen it used, nor yet made any use of it, although I have been in command 18 years. My opinion is now altered, for it was used on board this steamer January 31st, 1892, with great effect. We were in lat. 37° 45′ N., long. 70° 41′ W., the wind was from North, force 10, with a heavy broken sea. I wanted to get back to port (New York), but the ship had a list to starboard of 15° or more, and by steering a westerly course I should be placing the lame side to wind and sea, which was dangerous. But in such times one passes danger on one side and does one's best. Therefore I ordered the course W. ½ S., and showed the decks to wind and sea, and put the engines at full speed. Two or three treacherous seas came along and filled the decks, fairly rolling over the ship, making the whole frame shake. Then the second mate asked permission to put an oil-bag over. It was placed on the starboard bow. The change was magical; the sea became moderately smooth all along the lame starboard side. The Oil could be seen on the water, being in fact used very freely at first from two grain-bags, one within the other; afterwards we used canvas bags. In this way we steamed 4 or 5 hours, when I was compelled to lie-to for the night, considering the ship's heavy list to starboard. The using of Oil has altered my opinions, and in future, as soon as any sea begins to make, I shall at once start for the engine-room after Oil."

On February 12th and 13th, 1892, the Dutch steamer *Oranje Nassau*, was subjected to W.N.W. gales of great violence, between lat. 31° 40′ N., long. 74° W., and lat. 32° 5′ N., long. 74° W. The storm lasted about 24 hours, during which thick Oil was used in two bags, one at each bow. The seas were very heavy from W.N.W. to N.N.W., but no water came on deck, as there would have come had no Oil been used, for the seas were so high that the vessel sometimes rolled 45° from the perpendicular. The amount of Oil expended was about one quart per bag every four hours.

Capt. Murdock, of the ship *Sierra Lucena*, states:—" I have found the use of Oil in heavy seas of very great benefit. On one occasion, when in a cyclonic gale off the Cape of Good Hope, with the lower main topsail blown clear out of the bolt-ropes and the ship lying on her beam-ends, with the water above the lee dead-eyes, used Oil with perfect success. Two other vessels which we spoke the day before the gale were never heard of afterwards. We used half colza and half raw linseed oil, and allowed the bags to float out, with long lanyards.'

Capt. Dayton, of the brig *T. Towner*, from St. Croix to New York, reports that:—" After being crippled on August 21st, 1893, by losing the foremast in a Hurricane, we got into another on August 24th, blowing severely from the S.E. The sea was so terrific that, had it not been for the free use of Oil over the bows, the vessel would have foundered."

Capt. Foster, of the steamer *Wm. Crane*, from Baltimore to Savannah, on August 27th, 1893, encountered a Hurricane between Cape Henry and Hunting Island:—" Met tremendously high seas, which broke on board. Put three oil-bags over the bows and poured Oil down the water-closets. This saved the ship. No more seas came on board. Used six gallons of signal Oil; half of it in the water-closets."

Other reports, similar to the above, are constantly coming to hand, and the great importance of this subject is now becoming widely recognised.

6.—CLASSIFICATION OF THE CLOUDS.

Since the discovery of Buys-Ballot's Law (page 113), and of the Cyclonic and Anti-cyclonic Gales of extra-Tropical latitudes, the study of the Clouds has assumed a new importance, as showing the movements of the air in the upper atmosphere, but, in the first place, it requires a practiced eye for Cloud observations, and this no person has a better chance of acquiring than the seaman. There is at present not enough known of the subject to lay down any very reliable rules, and there is great practical difficulty even in drawing up a system of nomenclature, which can be universally adopted. Many capable observers are now actively engaged in the study of this subject, and we cannot afford space here even to give a list of the works written by them. Many valuable Papers, well illustrated, are to be found in recent "Journals of the Meteorological Society," especially that for 1887, to which the student is referred for full particulars.*

On pages 200—203 we have previously given some particulars, illustrated with a diagram, of the distribution of Clouds within the areas of Cyclonic Storms passing over the British Isles, mainly due to the Rev. W. Clement Ley, M.A., F.M.S., who has devoted many years to the study of this subject. A remarkable feature is the direction taken by the higher Clouds in these storm areas; with the wind in one of these storms blowing on the observer's back, the Clouds high in the atmosphere indicate that the direction of the wind is from left to right of the observer, which would seem to show a rising of the wind in a spiral form.

"The researches of Mohn, Hildebrandsson, Buchan, Ley, and others, seem to prove that in all cases which they have investigated by means of wind direction and the motion of *Cirrus* clouds, the air flows spirally into an area of low pressure at the surface of the *earth*, and to some extent out from it in the upper regions of the air; whilst the order is reversed with areas of high pressure, the lower air flowing *out from*, and the upper air *in towards*, their centres. It remains to be proved whether the same law holds good with regard to the area of high pressure in the centre of the Atlantic. . . . . . It must be remembered that there are upper currents of air which (owing to the absence of moisture) do not carry Clouds along with them, and that they need some other means than Cloud motion to detect them."—*Captain Henry Toynbee.*

Mr. Ley, and numerous other meteorologists, also consider that the classification of the late Mr. Luke Howard, which has been in use for the greater part of this century, is not suitable for the present state of weather knowledge. Without materially altering the old nomenclature, they are of opinion that the Clouds may be divided into *Upper* and *Lower* Clouds, or those high in the atmosphere, such as *Cirrus*, *Cirro-cumulus* and *Cirro-stratus*, and those nearer the earth's surface, including *Stratus*,

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* See, also, "Modern Developments of Cloud Knowledge," by the Hon. R. Abercromby, in the "Journal of the Scottish Meteorological Society," 1889, pages 3—18.

Cumulus, *Cumulo-stratus*, and *Nimbus*.* With regard to form or appearance, they may also be divided into two classes, both occurring at all altitudes, viz., fibrous or linear, which tend to arrange themselves in layers, lines, or streaks; and massive or compact, which take the form of heaps or piles.†

Clouds are seen at all levels between the highest *Cirrus* and the lowest *Stratus*, so that it is often difficult to determine whether a particular sheet or layer of Cloud belongs to the upper or the lower system. In such cases, the observer will be greatly assisted by remembering how the Clouds have become formed, whether by the gradual subsidence of the highest forms, or by the ascent of the lower Clouds.

The naming of Clouds is a most difficult subject for observers, and that attended by most mistakes. The misnaming of certain Clouds is the cause of most error: Cirro-cumulus and Cirro-stratus for example; Nimbus, too, no matter from what form of cloud rain falls it is called Nimbus. It should be noted that Clouds of slight vertical depth, compared with their area, belong to the Stratus types, while those that assume solid and rounded masses are Cumulus forms.‡

In the Trade Wind region, by observing the direction of the upper Clouds, it would appear that an opinion may be formed of the probable direction of the squalls in unsettled weather, as previously remarked by Captain Toynbee (pages 260—261).

The Upper Clouds are considered on good authority to be composed of particles of ice, inasmuch as the phenomena of halos, &c., are produced by them, and these can only be explained by the refraction of the rays of light through ice-crystals.

Cirrus is often seen after a continuance of fine light weather, as a fine whitish line of cloud, stretched across the sky at a great height, the ends seeming lost in the horizon. This is often the first indication of a change to wet weather; to this line of Cirrus others are added laterally, and at times clouds of the same sort seem to proceed from the sides of the line, and are sent off in an oblique or transverse direction, so that the whole may have the appearance of net-work. The line alluded to above is called

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* In abbreviating these names the following system has been used by the Meteorological Office, as others have been found to mislead:—Cir.; Cir. c.; Cir. s.; Str.; Cum.; Cum. s.; Nim. Another system, now in use, is C. for Cirrus; S. for Stratus; K. for Cumulus; and N. for Nimbus. The amount of cloud is registered from 0 "Blue sky" to 10 "Entirely overcast."

† These classes cannot always be separated when the Clouds are near the zenith, and only their under-surfaces are seen; viewed laterally they are easily distinguished. It is important, however, to notice that the thread-like appearance of those Clouds, whose vertical diameter as compared with the horizontal is small, is always partially, and often wholly, due to perspective. Whether partially or wholly so, we can at once decide, by looking at the same kind of Cloud in different azimuth; *e.g.*, the bands of Cirrus are *real*, since they appear to converge in opposite points of the horizon; streaks of Stratus are mostly *phenomenal* only, since looked at all round the vault of the sky at the same distance from the zenith, they are commonly seen as lying in the same apparent plane.

‡ "Notes on taking Observations on Board Ship," by Capt. D. W. Barker, R.N.R., in the "Quarterly Journal of the Royal Meteorological Society," vol. xiii., 1887, page 187.

Linear Cirrus, and the transverse lines produce the *Reticulated* or *Curl Cloud.*

At other times the lines of *Cirrus* become denser, descend lower, and, by uniting or conjoining with others below, produce rain.

Comoid or *Hairy Cirrus*, commonly called *Mare's Tail*, is the proper *Cirrus;* it resembles, in appearance, a long lock of white hair, or a bunch of wool pulled out into fine pointed ends. The appearance of *Cirrus* often indicates wind and rain; and when the fine tails have a constant direction toward any one point of the compass, it has been frequently observed that the gale has sprung up from that quarter to which they previously pointed. It is often difficult to ascertain the direction of *Cirrus*, owing to its slowness of motion, but as indicating the difference between the direction of the wind at the earth's surface, and that of the higher regions, it is very important.

Cirrus is seen far above the highest mountains, and Mr. Glaisher concluded from his balloon observations that its altitude sometimes amounts to over 15 miles. According to Prof. Hildebrandsson's observations at Upsala, in Sweden, its mean altitude is 27,000 feet.

The Lower Clouds are usually composed of particles of condensed vapour or "bubble-steam," *i.e.*, of water, not of ice; when they are interposed between the sun and the moon, they dim or intercept the light entirely, without giving rise to *halos* or *coronæ.* They may be described as follows:—

Cirro-stratus and *Strato-cirrus* differ little in form, but much in height, the former having a mean altitude of 27,500 ft., and the latter ranges as low as 15,000 feet.

Cirro-stratus (Cirrus and Stratus), or *Wane Cloud*, is composed of horizontal or slightly inclined masses of small clouds, attenuated toward a part or the whole of their exterior, bent downward or undulated, separate or in groups, and generally with a sinking barometer, indicating a decrease in temperature, with wind and rain or snow.

Cirro-stratus is characterised by great horizontal extent in proportion to vertical breadth; so that when any other Cloud begins to assume that form, it generally ends in Cirro-stratus. Cirrus more commonly becomes Cirro-stratus than any other Cloud; Cirro-cumulus next; and then Cumulus. Cirro-stratus, once formed, sometimes resumes the modification from which it originated, but more frequently it gradually evaporates or conjoins with some other modification. It seldom remains long in one form, but seems to be constantly declining, and hence the term of *Wane Cloud.* It is sometimes composed of wavy bars or streaks, connected in the centre and confused, but the streaks more confined at the edges; this is common in variable weather in summer. The *Mackarel Sky*, as it is termed, is a variety of this; another variety consists of one long and plain streak, thick in the middle, and wasting away at its edges; and a third, consisting of small rows of little clouds, curved in a peculiar manner, and a sure indication of stormy weather; this is more or less regularly formed, and the irregular formation is often produced when a large Cumulus passes under a long line of Cirro-stratus, and is also a sign of stormy weather.

The last variety of Cirro-stratus is a large shallow veil of Cloud, which extensively-overspreads the sky, particularly in the evening and during the night, and through which the sun and moon appear dimly. It is in this Cloud that those peculiar refractions of light, of the sun and moon, called *halos*, *mock suns*, &c., usually appear, and which are tolerably certain prognostics of rain or snow. There are minor varieties which may frequently be observed.

Cirro-stratus usually terminates in forming an intimate union with some other Cloud, to produce rain; but at times it evaporates or changes into some other modification.

Cirro-cumulus and *Cumulo-cirrus* are scarcely distinguishable, both appearing as thin layers of fleecy structure, but the former float at a mean altitude of 20,000 ft., while the altitude of the latter only averages 12,000 feet.

Cirro-cumulus (Cirrus and Cumulus) is an assemblage of *nubeculæ*, or small roundish clouds, either detached from, or in contact with, each other, and frequently reaching, to appearance, into the azure sky, commonly attended by an increased temperature, and found to accord with a rising barometer. The most striking feature is observed in summer, before or about the time of thunder-storms. The component nubeculæ are then very dense, round in form, and in closer apposition than usual. This kind of Cloud is so commonly a forerunner of storms, that it has been assumed by some as a tempestuous prognostic. In rainy and variable weather another variety of this Cloud appears, contrasted very strikingly with that above mentioned, being of a light fleecy texture, without any regular form in its nubeculæ. Sometimes the latter are so small as scarcely to be discernible, but the sky seems speckled with innumerable little white transparent spots. The Cirro-cumulus of fair summer weather is of a medium nature, not so dense as the stormy variety, nor so light as the variable one. Its nubeculæ vary in size and proximity. In fine dry weather, with light gales of North and easterly winds, small detachments rapidly form and subside again, generally in a horizontal arrangement.

When Cirro-cumulus prevails, we may anticipate an increase of temperature in summer; and in winter the breaking up of a frost, or warmer and wet weather. In the summer time, extensive beds of this Cloud, viewed by moonlight, have a very beautiful appearance, which has been compared to a flock of sheep at rest. Cirro-cumulus subsides either slowly, as if by evaporation, or changes into some other modification.

Stratus comprehends fogs and all those creeping mists which in summer evenings fill the valleys, but disappear in the mornings. The best time for observing its formation is on a fine evening, after a hot summer's day; we shall then observe that, as the Cumuli of the day decrease, a white mist forms near the ground; this Cloud, as the Cumuli evaporate, by degrees arrives at its density. In autumn it remains longer in the morning. In winter it often puts on a still denser appearance, and remains during the day, and even for many days successively.

Cumulus is a flat-based rocky-topped Cloud, whose base is usually elevated about 4,500 feet. The progressive formation of Cumulus is seen in fine settled weather. If we then observe the sky soon after sunrise, we see small clouds here and there in the atmosphere, which appear to be the result of small gatherings, or concentrated parts of the evening mist, which, rising in the morning, grow into small masses of cloud, and the atmosphere becomes clear. As the sun rises, these clouds become larger, by adjacent ones coalescing, and at length a large Cloud is formed, assuming a cumulated irregular hemispherical shape; this usually subsides in the evening as it is formed in the morning, breaking into small masses, then fragments, and evaporating, when it is succeeded by Stratus, to the formation of which it may have contributed. In fine weather these Clouds form soon after sunrise, increase during the day, and subside with more regularity, and have a more hemispherical form, than in changeable weather. When well-formed Cumuli prevail for three or four days, the weather is settled. Cumuli reflect a strong silvery light when opposed to the sun, like Alpine mountains covered with snow.

Cumulus sometimes takes a cylindrical shape, forming itself into long horizontal rolls, between which gleams of light are seen, but which are often so closely packed as to hide the blue sky; these are called *Roll-cumulus*. This variety of Cumulus is an addition to Howard's nomenclature. It is inserted owing to the frequency of this appearance at sea, but it is necessary to observe that the effect is simply one of perspective.

Cumulo-stratus designates Cirro-stratus blended with Cumulus, and either appearing intermixed with the heaps of the latter, or super-adding a wide structure to its base. Cumulo-stratus is most frequent during a mean or changeable state of the barometer, when the wind blows from the West, with occasional deviations from the North and South. Its mean altitude is about 6,000 feet.

This Cloud may be always regarded as a preliminary to the production of rain; and it frequently forms in the following manner:—the Cumulus, which in common passes along in the current of the wind, seems retarded in its progress, increases its density, spreads out laterally, and at length overhangs the base, in dark and irregular protuberances. The change to Cumulo-stratus often takes place at once in all the Cumuli which are near to each other; and their bases uniting, the superstructure rises up with mountain-like or rocky summits. The change from Cumulus to Cumulo-stratus is often preceded by Cirro-stratus.

Cumulo-stratus varies in appearance; those Clouds in which hail showers and thunder storms form, look extremely black before the change to rain, and have a menacing aspect, as they are seen coming slowly up with the wind. Cumulo-stratus sometimes evaporates or changes into Cumulus; but, in general, it ends in Nimbus and a fall of rain or snow. Sometimes only one part forms Nimbus, the other remaining Cumulo-stratus.

Nimbus is a flat rain-cloud, whose average altitude is from 4,000 to 5,000 feet. *Cumulo-nimbus* is a rain-cloud, of a rocky appearance, whose base is usually elevated about 4,500 ft., while its summit may rise to 9,000 feet.

Nimbus always precedes a fall of snow, rain, or hail; and has received its name from a notion of the ancients, who distinguished between the *Imber*, or shower, and the *Nimbus*, or cloud, from which the rain comes.

General Remarks on the Nimbus.—Any of the modifications just described may increase so much as to obscure the sky, without ending in rain; before which, the peculiar characteristic of the rain-cloud may always be distinguished. In order to get a clear idea of its formation, you may observe a distinct shower in profile, from its formation to its fall in rain. You may then observe Cumulus first arrested, then Cirro-stratus or Cirrus may appear to alight on its top; the change to Cumulo-stratus then goes on rapidly, and this Cloud, increasing in density, assumes that black and threatening appearance known as an indication of rain. Presently this blackness is changed to a grey obscurity, and this is the criterion of the actual formation of water, which now begins to fall, and constitutes the cloud a *Nimbus*, while a Cirriform crown of fibres extends from the upper part of the clouds, and small Cumuli enter into the lower part. After the shower has spent itself, the Cloud resumes its title of Cumulo-stratus, and thence probably changes into a different modification; and if Cumulo-stratus appears again, it indicates a return to rain.

7.—ON MAGNETISM AND THE COMPASS.

Concerning the history of the magnetic needle, we have many and vague notices of its high antiquity. It is mentioned by Homer and Aristotle, and by many subsequent classical writers. To come to more modern times, it was known, in Europe, at the time of the Crusades, in about A.D. 1150, and it is very probable that the knowledge was derived from the Arabians, during those expeditions. The Chinese were acquainted with it ages before this. We are told by the Jesuit missionary, Du Halde, that the Chinese Emperor, Hoang-ti, possessed an instrument which pointed to the *South*, so early as the year 2634 B.C., or over 4,500 years ago; the same author gives subsequent notices of the Compass in China, proving its very great antiquity among that people.

It has usually been considered that Columbus, in his voyage from Portugal, on the discovery of America, first observed the *Variation* of the needle from the true North. But it is not improbable that the Variation was discovered nearly 200 years before Columbus made this change known, as it is mentioned in one of the earliest treatises on Magnetism, by Peter Adsiger, in 1269; the authenticity of this, however, is doubted by some. The wonderful property of the *Dip* of the needle was first observed by our countryman, Robert Norman, a maker of compasses, in 1576.

Magnetism is a principle which is evidently allied to, if it is not identical with, Electricity and Galvanism. For, in causing any or either of these principles to become evident to our senses, we produce, at the same time, the others; and it may be here stated, that five apparently dissimilar effects are inevitably caused in the production of either, viz., Light, Heat, Chemical Action, Electricity, and Magnetism. By the production of *Light* we cause Heat and Chemical Affinity, and these will also produce *Electricity*, and will cause the magnetic needle to swerve from the meridian. By the Electric Fluid we produce *Light*, *Heat*, and the other phenomena; and the magnetic needle is a measurer, by its deflections, of the most minute portions of Galvanism. From the *magnet* a spark can be produced, absolutely similar in appearance and effect to that of Electricity and Galvanism; and there is a positive and negative, or North and South, pole to the magnet, and these attract or repel each other.

There is one phenomenon connected with these sciences of very great importance in practice, and that is, that of *induction*. A substance electrified *positively* will *induce* a state of *negative* electricity, or will cause a body that is within its influence to be negatively electrified; the North pole of a magnet will induce an opposite pole in that of another piece of iron, in certain positions with respect to the magnetic meridian and itself. Thus, the iron employed in the construction of a ship, or contained in its cargo, may all become, by *induction*, temporary magnets, and have a most marked and important effect upon the Compass by which it is steered; and it is this cause which is too frequently overlooked —that of *Local Deviation*—which has caused enormous errors in reckoning, and consequently the loss of many vessels. As scientific detail is out of our province, we must refer the reader to those works more expressly treating on the subject.

Terrestrial Magnetism.—The cause of the Magnetism of the earth, by which the Direction, the Dip, and the Intensity of the Force of the magnetic needle is controlled, is still involved in obscurity, and no perfectly satisfactory system or theory has hitherto been framed to account for the multifarious changes and phenomena of the Compass needle. Among the more modern enquirers into the source of this most wonderful principle, we may mention Professor Hansteen, Mr. Bain, Mr. Barlow, Mr. Christie, Sir Edward Sabine, Mr. Gauss, Capt. Johnston, Mr. Archibald Smith, Captain Evans, R.N., and many others. From their labours we have arrived at a tolerably correct notion of the *general effects* of magnetic phenomena; and from these the laws by which they are governed have, in some measure, been deduced.

Now, the most reasonable supposition is, that the earth itself is a magnet, or that magnetic currents exist on its surface in certain directions, causing the various deflections of the needle; whether this Magnetism is *induced* from the sun, or other source, or whether the earth is in a positive and permanently magnetic state, does not affect the present question. From certain changes in the Compass, perhaps it might be inferred, that the Magnetism is *induced* by temperature (heat) from the sun; or that the ferruginous matters, which enter so largely into the composition of the earth, have received an inductive Magnetism from the same source. In 1839, Gauss, among other important conclusions derived from his researches, considered that the agents producing the magnetic force of the earth are situated exclusively in the interior of the earth, and that they are not situated in external space.

In 1683 Dr. Edmund Halley published a theory of Magnetism, in which occur the following ideas:—that the earth's Magnetism was caused by *four piles or points of attraction*, two of them near each Pole; and that in those parts of the world which lie nearly adjacent to any one of those

Magnetic Poles, the needle is governed thereby, the nearest Pole being always predominant over that more remote. This view of the earth's Magnetism was supported by the results of the labours of Professor Hansteen, one of the chief promoters of the science, as shown in his most valuable work (*Magnetismus der Erde*, Christiania, 1817). Having collected all the observations of value that had been made on the Variation of the needle, he proved that there were *four points* of convergence among the lines of Variation ; viz., a weaker and a stronger point, in the vicinity of each Pole of the globe. This, combined with the result of Sir D. Brewster's inquiries, will certainly lead to the view of the connection between the heat of the earth and its Magnetism. Professor Hansteen considered that the strongest Poles, N. S., lie almost diametrically opposite to each other, and the same is true of the weaker Poles *n. s.* These four Poles he found to have a *regular motion* obliquely; the two Northern ones, N. *n.*, from West to East, and the two Southern ones, S. *s.*, from East to West. The following he found to be their periods of revolution, and their positions in 1830 :—

	Latitude.	Long. from Greenwich.	Time of Revolution round each Pole of the Earth.
Pole N.	69° 30′ N.	87° 19′ W.	1,740 Years.
Pole S.	68° 40′ S.	181° 47′ E.	4,609 ,,
Pole *n.*	85° 6′ N.	141° 17′ E.	860 ,,
Pole *s.*	78° 29′ S.	137° 45′ W.	1,304 ,,

From calculations based upon subsequent observations he slightly varied these positions and periods ; but he showed very clearly that the changes in the Variation and Dip of the needle, in both Hemispheres, may be well explained by their motion.

Recently acquired knowledge enables us to understand the arrangement of these Poles to be as follows. In each Hemisphere there is one *Magnetic Pole*, where the magnetic needle would take up a vertical position. The *Northern Magnetic Pole* is to the N.N.W. of Hudson's Bay, in about lat. 70° N., long. 96° W. ; the *Southern Magnetic Pole* is to the South of Tasmania, in about lat. 73½° S., long. 147½° E. These Poles must not be considered as mere points on the earth's surface, but rather as limited areas ; at the Northern Pole, the dipping-needle has been found by actual observation to be vertical over a region of some 50 miles square.*

Besides the Magnetic Poles, the directive power of the magnetic needle is also affected by the *Magnetic Force*. This is not evenly distributed over the earth's surface, and the points of maximum intensity do not coincide with the Magnetic Poles. In the Northern Hemisphere there are two foci of maximum Force, the more powerful in about lat. 52° N., long. 92° W., near the great American lakes, the weaker in Siberia, in lat. 65° N., long. 115° E. It is also believed that two similar foci, of nearly equal power, exist in the Southern Hemisphere, one in lat. 65° S., long. 140° E., and the other in lat. 50° S., long. 120° E.

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* "The Magnetism of the Earth. A Lecture on the Distribution and Direction of the Earth's Magnetic Force at the Present Time: the Changes in its Elements, and on our Knowledge of the Causes." By Captain F. J. Evans, C.B., F.R.S., in the "Proceedings of the Royal Geographical Society," No. iii., vol. xxii., 1878, pages 188—216.

By the action of the dipping-needle, the line of Force is found to be horizontal only in Equatorial and Tropical regions, and to lie below or above the horizontal plane when to the North or South of the Magnetic Equator. The direction taken by the Compass needle invariably leads to the Magnetic Poles, around which the lines of Equal Dip are arranged in a series of circular or elliptical curves. The maximum Magnetic Force is not coincident with the Magnetic Poles, nor lines of Equal Force with lines of Equal Dip.

The Magnetic Poles, or points on the earth's surface over which the dipping-needle would stand vertical, are separated by a *Magnetic Equator*, which is not coincident with the earth's Equator, but is an irregular circle, which crosses it in two points, one in mid-Pacific, and the other in 12° W. in the Atlantic; on this circle, of course, the dipping-needle remains horizontal.

Respecting the North Atlantic Ocean, we may here state that in 1895, the Magnetic crosses the Terrestrial Equator in about long. 12° W., and proceeds south-westerly, across the Atlantic, to the coast of Brasil, which it touches in lat. 14° S. The line of Equal Dip, at 70°, runs from the N.W. coast of Ireland, curving to the W.S.W., to about Washington, U.S.; between these lines the lines of Equal Dip (or *Isoclinal Lines*) form nearly regular divisions, as will be seen by referring to the diagram, page 455.

The Mariner's Compass, as generally used, exhibits the direction of the Magnetic meridian only; and in treating of the magnetic needle, for the purposes of navigation, three points are to be inquired into—these are, the *Variation*, or *Declination;* the *Dip*, or *Inclination;* and the *Intensity* of the Magnetic Force.

The Declination, or Variation.—With this branch of the subject every sailor must be perfectly familiar, and any comment on its actual state is therefore unnecessary. It is described as *positive* when Westerly, and *negative* when Easterly. But this Variation is not constant. There are several elements of change in this part of the Magnetic Force, for it undergoes Secular, Annual, Mensual, Diurnal, and also irregular Changes. The *Secular* Change is a progressive alteration observed in the direction of the magnetic needle during a series of years. Thus, in 1576, Robert Norman found the Compass in London to point 11° 15′ *East* of North; in 1658, it pointed true North; it was on the increase in 1819, when it was 24° 41′ *West* of North; and since then it has been retrograding, and in December, 1891, was 17° 20′ 30″.

The *Mensual* Change is according to the season of the year. It was first noticed by Mr. Canton about the year 1756. It amounted, in January, to 7′ 8″; in March, 11′ 17″; in June, 13′ 21″; in September, 11′ 43″; and in December, 6′ 58″.

The *Diurnal* Change is thus described from the observations of Professor Lloyd :—" The mean daily curve of the Changes of Declination for the entire year exhibits a small Easterly movement of the North end of the magnet during the morning hours, which reaches its maximum about 7 a.m. After that hour the North end moves rapidly Westward, and it reaches its extreme Westerly position at 1.10 p.m. It then returns to the Eastward, but less rapidly, the Easterly Deviation becoming a maximum about 10 p.m.; the mean daily range equals 9·3′."

The *Irregular* Changes or *Magnetic Storms*, as they have been termed (see page 458), occur without any previous notice, and are of very great extent; some of them almost throughout the globe. At times this Deviation amounts to 2°.

The ascertained Variation of the Compass, in various parts of the North Atlantic Ocean, is attached to the Tables of Positions in the former part of this work, and are also given on the Chart facing page 455.

The Dip, or Inclination.—The Dip of the needle is the angle which a well-balanced needle forms with the horizon after it is rendered magnetic, and when it has the power of free motion in the plane of the magnetic meridian. As before stated, this angle varies in different parts of the globe, being at zero on the Magnetic Equator, and 90° on the Magnetic Poles. The Dip, like the Variation, undergoes a continual change, increasing in some parts of the world, and diminishing in others. Thus at Paris, in 1761, it was 75°; in 1829, only 67° 41′. At London, in 1576, it was 71° 50′; in 1837, it was 69° 20′; in 1891, it was 67° 21·4′.

The Dip is a very important element in magnetic consideration, and is too much overlooked by the sailor. The instruments for its measurement, however, are expensive and delicate, and require great nicety in their management; and for these reasons it is comparatively neglected; but as it is in some degree a measurement of the Intensity of the Magnetic Force, and also greatly modifies the directive power of the Compass, it is very important to the mariner. When the needle is perpendicular, as it is over the Magnetic Poles, of course its directive force vanishes. The diurnal change in the Dip amounts to 3′ or 4′, and is also about 15′ greater in summer than in winter.

The Intensity.—The Intensity of the Magnetism of the earth varies also with time and place. It is the power of the earth to bring an oscillating needle to a state of rest; and it is in proportion to the squares of the number of vibrations per second. The lines of Equal Intensity would at first seem to coincide with those of Equal Dip, but, in consequence of the double Magnetic Polar axes, they differ in their relation, though they still form regular and symmetrical curves. As the Magnetic Latitude increases so does the Intensity, but not the Directive Force; for, when a needle is on the Magnetic Equator, it naturally preserves its horizontality, and, consequently, the whole of its Magnetism is employed in directing the needle towards the Poles. But, in high Magnetic Latitudes, where the Dip is great, the means employed to keep it parallel with the horizon of course reduce very considerably its power of keeping in a North and South direction; and in the circum-polar regions the ordinary Compass becomes so sluggish as to be of but little value to steer by.

Having thus very briefly sketched the general phenomena of Terrestrial Magnetism, the reader will understand the general principles laid down by Dr. Halley and Professor Hansteen, that in the Northern Hemisphere the two points of convergence of the Magnetic Variation or Declination, by revolving around the Pole of the earth, will cause a local change in the Variation of all places lying in North Magnetic Latitude, and which, in the case of London, has amounted to about 28½° in 315 years. The Dip, on the other hand, has changed but little, or 4½° in the same period; this is obvious, because the two magnetic axes, while they change their Terrestrial Longitude in a considerable degree, do not vary much in Latitude, and, consequently, will not greatly affect the Dip in places at some distance from them.

The points then, interesting to the navigator, are, first, the influence of the earth's Magnetism upon his Compasses, and the influence the ship and her iron has upon them in neutralising or modifying the first; the second, namely, the *Local Deviation*, is a subject which has become magnified into vast and vital importance since the introduction of iron and steel into the fabric of ships.

The North Atlantic Ocean has this peculiarity, in a magnetic sense, that it has over nearly all its area but one kind of Magnetism—Westerly Declination (or Variation) and Northerly Inclination (or Dip). The Magnetic Equator, or the line of No Dip, passes, as before said, obliquely across the Terrestrial Equator, from Africa to Brasil. The line of No Variation passes from Charleston, across the West Indies, to the River Essequibo.

Now, as will be seen presently, as the force of the ship's Magnetism diminishes, so does that of the earth increase in its influence on the Compass, so that a ship's *corrected* Compass does not hold the same relative position with respect to both, with the same correction, into a different Magnetic Latitude. Thus, a vessel with a large original error in England will find that error reduced, perhaps to one-half, on reaching the Equator; and if sailing Northwards a very different relation will be found.

This is especially to be noticed on sailing into the Gulf of St. Lawrence, or anywhere in a N.W. direction towards America. Frequently a ship may be standing on one course to the southward of West across the Atlantic, and then suddenly bears up to N.W.; and then, passing rapidly towards the Magnetic Pole, the relation between the earth's Magnetism and that of the ship upon her Compass undergoes a rapid and important change, which, unattended to, has doubtless been the cause of many embarrassments and accidents.

The Local Deviation of the Compass is its variation from the Magnetic Meridian, which may be caused, as already noticed, by a peculiar state of the atmosphere, Aurora Borealis, lightning, or the local attraction of the ship, iron, &c. This is a subject of inquiry, which was first explained by Captain Flinders, in the description of his surveys of the Australian coast. To this subject his attention was directed, not only by some anomalous differences which he found in the Compasses he used, but by others recorded by Mr. Wales, who had accompanied Captain Cook in the capacity of astronomer, and his deductions, referring as they do to wooden vessels, are still held to be correct.

But the problem of Local Deviation in *iron ships* is a widely different one, and includes a large range of phenomena and considerations which, for many years after the introduction of iron as a material for building ships, was but little understood, and even now is not established on a firm basis in all its particulars.

This important discussion, upon the Magnetism of Iron Ships, began by Professor Airy's experiments, recorded in the "Philosophical Transactions" for 1839. His conclusions were somewhat opposed by Dr. Scoresby, in 1854, which was replied to in the "Mercantile Marine Magazine," in 1854 and 1855. To further investigate the still obscured principles involved in this very important topic, Dr. Scoresby undertook his well-known voyage to Australia and back, in the *Royal Charter*, between February and August in 1856.

The attention of the shipping interest was strongly called to this question at the meeting of the British Association at Liverpool, in 1854, and the result was the formation of the Liverpool Compass Committee, who reported to the Government, in 1855 and 1856, and the valuable series of observations they collected were discussed by their able secretary, Mr. Rundell, and by Mr. Archibald Smith, Mr. Towson, and others, in 1857. One important conclusion arrived at is stated by Mr. Archibald Smith, as follows:—

"Whatever differences of opinion may be entertained as to applying corrections to the steering Compasses of iron ships, it can hardly admit of question that every iron ship should have at least one Compass removed as much as possible from the influence of iron and *not corrected* by magnets, and should be swung at the beginning and end of every voyage of any length, and the Deviation of the uncorrected and corrected Compasses (if any) observed. No man is competent to command an iron ship who is not competent to make these observations."*

More refined calculations, for determining the relation between a ship and her Compass, were given in a pamphlet by Archibald Smith, Esq., "Instructions for the Computation of a Table of the Deviations of a Ship's Compass," 1848, as a supplement to the "Practical Rules for ascertaining the Deviations, &c.," 1854.

Dr. Scoresby gave the following summary of leading deductions on the Character, Distribution, and liability to Change, of the Magnetism of Iron Ships:—

(1.) *As to the Sources of the Intense Magnetism of Iron Ships.*—Ships built of iron must not only be strongly magnetic, because of the vast body of this metal which is subjected to the action of terrestrial induction; but by reason of the elaborate system of hammering, as well as from the bending of the plates and bars during the progress of construction, there must be an *extremely high* development of the quality of *Retentive Magnetism.*

(2.) *Effect of the Position of a Ship when Building.*—Each iron ship must have a special individuality of the magnetic distribution, depending *essentially* on the position of the keel and head whilst building, such distribution having, in each individual case, a Polar axis and Equatorial plane conformable to those of the earth at the place where the ship is built.

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* From the Introduction to Dr. Scoresby's "Journal of a Voyage to Australia," by Archibald Smith, Esq., M.A., page 48.

(3.) *Magnetic Lines of the Inductive and Retentive Magnetism the same.*—Whilst the spontaneous influence of simple induction must be to develop a transient magnetic condition, having in each individual case a Polar axis and Equatorial plane conformable to those of the earth at the place where the ship is built; so, also, the Retentive Magnetism developed during the building must have corresponding Polar direction and distribution.

(4.) *Liability of original Magnetic Distribution to Change.*—The original distribution of the Magnetism, or casting of the magnetic lines, must be liable to change, after the launching, under any violent mechanical action on the ship, when lying with her head in a new direction, or sailing in remote regions of the globe, having very different directions of the earth's Magnetic Force.

(5.) *Sympathy of the Compass with a ship's Magnetic Changes.*—All changes in a ship's magnetic condition must tend to produce disturbance in the action of Compasses on or about the deck. And the effect must be, in however minute or insensible quantity in some particular cases, to change the amount of the original *Deviations.*[*]

It was the argument on the "retentive" condition of the Magnetism of the ship induced by her building, that led to the controversy between Dr. Scoresby and Professor Airy, and caused the former undertaking, at his advanced years, the voyage to Australia, from the effects of which he may be said to have fallen a martyr to science.

Dr. Scoresby, in his letter to the Underwriters Association of Liverpool, in 1854, drew up the following propositions, in addition to those he laid down in his later work of the "Voyage of the *Royal Charter:*"—

1. That the original Magnetism and Compass Deviation are specially liable to change in *new* ships, when meeting with heavy weather on their first going to sea.

2. That a *Change of Course,* after long steering in one direction, is liable to produce a Change in the Compass.

3. That adjusted Compasses are specially liable to change in the direction of over-compensation, and may dangerously mislead the navigator.

4. That a *stroke* of the sea may produce a sudden change in the Compass.

5. That a stroke of lightning may change a ship's Magnetism and Compass Deviation.

6. That a *hot* sun, shining *partially* on an iron ship, might change her Magnetism.

7. That permanent magnets applied for the adjustment of Compass Deviations must, with rare exceptions, tend to aggravate the error in ships going far into another hemisphere.

8. That a compass aloft affords an easy, practical, and, if duly elevated and prepared for, an effectual remedy for the ship's disturbing influence.[†]

The experience gained by the voyage of the *Royal Charter* showed that the blows and strains she underwent in her voyage out to Australia diminished, or, so to speak, shook out the inequalities in her Compasses, which were observed before her sailing, to such an extent, that the standard Compass, which had originally a deviation of 20° to the port side when the ship's head was North, had this deviation reduced to 3° 22′ on her return to Liverpool; while her steering Compass, which originally had been rather over-corrected, having an error of 1° 43′, returned with it 22° 25′; while the companion Compass, having an error of 1° 43′, returned with it 17° 35′. This change was one which had evidently taken place in the Retentive Magnetism of the ship. The change shows the complete failure, in such a voyage, for compensation by *fixed magnets.*

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[*] "Journal of a Voyage for Magnetical Research," 1859, pages 71, 72.

[†] "The Compass in Iron Ships, &c.," by the Rev. W. Scoresby, D.D., pages 67, 68.

In 1843, when the Compass Department of the Admiralty was established, the science and the instruments were in an equally bad condition. The labours of Captain E. J. Johnson, R.N., F.R.S., however, soon put a new face on matters, and much was done in his time towards developing the application of the principles enunciated. But the vast increase of iron shipping has caused greater requirements, and the sailor is very largely indebted to Captain (afterwards Sir) Fred. J. Evans, R.N., who produced an excellent series of Variation Charts, and also devoted much talent to the investigation of the problem of Magnetism in Iron Ships. From his Report on the Deviation in the Iron Ships of the Royal Navy, April 18th, 1860, we extract the following :—

On the Nature of the Magnetism in Iron-built Ships.—The magnetic influence of steam machinery having been reviewed, the nature of the Magnetism of iron-built ships can be entered on free, to a certain extent, of conditions arising from this extraneous source of Compass Error, and those examples fairly eliminated where it tends to embarrass the discussion.

The investigation of the disturbance arising from the horizontal induction of the soft iron in the ship, or the co-efficient D, offers several novel and suggestive points of inquiry; the chief characteristics are :—

1. That it has invariably a *positive* sign, causing an Easterly Deviation in the N.E. and S.W. quadrants, and a Westerly Deviation in the S.E. and N.W. quadrants.

2. That its amount does not appear to depend on the size or mass of the vessel, or direction when building, or on the iron beams.

3. That a gradual decrease in amount has occurred, when examined over a number of years, in nearly every vessel that has been reviewed.

4. That the value remains unchanged in sign and amount, on changes of geographic position, confirming theoretical deductions.

5. That a value for this co-efficient, not exceeding 4°, and ranging between that amount and 2°, may be assumed to represent the average or normal amount in vessels of all sizes.

The opinion has been long entertained, that the original Magnetism of an iron-built ship, or that acquired in the process of building, undergoes a rapid change after launching, and that from this cause accidents have occurred to recently launched and hastily equipped vessels. The records of ships of the Royal Navy do not illustrate this subject.

I have alluded to the importance of the conclusions to be derived from a review of the examples and cases given in this report; for although varying Compass disturbances exist, and the inference is irresistible that they arise from the nature of the iron employed in the construction of the hull of the ship, there is no doubt that, by attention to a few leading principles in the building and equipment of iron ships, larger and uncertain sources of error may be modified and reduced within limits both of fluctuation and amount, which will not seriously compromise the safety of the ship in the hands of an ordinarily prudent seaman.

The points of practical import to which I would invite attention are:—

1st. The best direction, with reference to the Magnetic Meridian, for the keel and head of an iron ship to be placed for building, to ensure the least Compass Disturbance.

2nd. The best position and arrangement for a Compass, to ensure small Deviations, and permanency on changes of geographic position.

3rd. The changes to which the Compass is liable, from various causes, when the foregoing conditions are fulfilled.

1. On the Best Direction for Building an Iron Ship.

In those built head N.E., East, West, and N.W., strong *South* polarity (or an *attractive* force on the North end of the Compass needle) obtains on one side of the ship, adjoining the Compass as usually placed between the middle section and the stern; the resulting disturbance is not lessened as the Compass is moved in a fore-and-aft line within these limits.

In vessels built head S.E. and S.W., *North* polarity obtains under the same conditions.

In vessels built head North or South, the conditions arise, that in the former the attraction is toward the stern (the topsides in their action being neutral to a Compass in the middle line of the deck), and diminishes in force as the Compass is moved towards the bow. In the latter, the law is reversed, and small Compass Deviations are obtained as the stern is approached.

In an iron *sailing* ship, built head to South, there will be an attraction of the North point of the Compass to the head; and if built head to North, a like attraction to the ship's stern; and so far there would seem to be no advantage in one direction over the other. But in the first case the topsides near the Compass have weak Magnetism; in the second case they are strongly magnetic; the first position seems, therefore, preferable.

In an iron steam-ship, built head to the South, the attraction due to machinery is added to that of the hull; whereas, in one built head to the North, the attractive forces of hull and machinery are, in the Northern Hemisphere, antagonistic, and a position of small or no "semi-circular" Deviation for the Compass may generally be obtained. In iron steam-vessels engaged on the home or foreign trades in the Northern Hemisphere, this direction of build is therefore to be preferred.

2. On the Position and Arrangement of the Compass.

The position of the Compass, whether standard or steering, must depend, as will have been observed from the foregoing conclusions, on the direction of the ship's build ; that is, in those built head North, the Compass must be as far removed from the stern as circumstances will permit; in those built South, placed as near to the stern as convenient, without approaching so close to the rudder-head, or iron taffrail, as to cause the ship's general Magnetism to be overpowered by the magnetic influence of those masses.

In ships built East or West, there is little choice of position, except to avoid, as a general rule, proximity to vertical masses of iron : in vessels built with their heads on the inter-cardinal points, a position approximating to the bow or stern respectively, where the action from the topsides (to be determined experimentally) is at a minimum, is to be preferred.

Ample elevation above the deck, and to be strictly confined to the middle line of the ship, are the primary conditions of position for every Compass in an iron ship, and no Compass, whether steering or standard, should be nearer the iron deck-beams than 4 feet; for the steering Compass this arrangement could be met by the use of a vertical card for the helmsman.

The *Standard Compass*, which, as a rule, I should recommend to be invariably uncompensated, requires an elevation of at least 5 or 6 feet from the deck, and to be fitted on a separate and permanent pillar or stand; it is by this superior elevation that the strong magnetic power of the iron beams and adjoining topsides are correspondingly lessened.

As every piece of iron not composing a part of, and hammered in the fabrication of the hull—such as the rudder, funnel, boilers and machinery, tanks, cooking galleys, fastenings of deck-houses, &c.—are all of a magnetic character differing from the hull of the ship, their proximity should be avoided, and, so far as possible, the Compass should be placed so that they may act as correctors of the general Magnetism of the hull.

A Compass placed out of the middle line of the deck is affected by the nearest topside, and its Deviations must necessarily be much increased if that topside has the dominant polarity, as in ships built East or West.

Experience has proved that the practical value of mast or elevated Compasses has, in some cases, been overrated ; they are, in fact, affected by the ship's Magnetism to an amount depending on their elevation and the direction of the ship's build ; thus, in ships built North and South, but especially the latter—the Compass being on the mizen-mast—the Deviations will be comparatively large. In ships built East or West, the Deviations will be comparatively small, from the topside, which would affect a deck Compass, being more directly under the mast Compass ; they may, therefore, be useful in the latter cases, and valueless in a ship built head to the South. The wear and tear on the pivots and agate caps of mast Compasses, from the increased motion due to their elevation, require constant attention when they are employed.

3. On various Sources of Error affecting a Compass placed under favourable Conditions.

Errors arising from changes of geographic position, as also incidental causes of error due to anomalous rather than general conditions, have been brought under review in the general progress of this report. There is, however, one source of compass-error (that arising from the *Heeling* of the ship) which has not been alluded to, as the ship in all the points hereto reviewed is assumed to be on an even keel, and neglect of this has led to the stranding of numerous vessels.

Experiments made in ships of the Royal Navy tend to prove, as also does the test of experience, that when the original Compass Deviations are small, the errors from Heeling are generally small in proportion; and conversely, the exaggerated errors from Heeling are the consequence of exaggerated errors while on an even keel. Ample elevation from the deck, in order to raise the Compass above the level of the topsides and adjacent deck-beams, is one of the chief conditions for reducing this source of error.

With head built	North,	on Heeling,	the North end of the Compass needle will be *attracted* to the weather or nearest side, from its *South* polarity.
,,	N.E.	,,	,, ,, the same.
,,	East	,,	,, ,, the same.
,,	S.E.	,,	the North end of the needle will have but little error, from the balanced conditions of North and South polarity of topsides.
,,	South	,,	the North end of the needle will be *repelled* to the lee side, by the *North* polarity of the nearest or weather topside.
,,	S.W.	,,	the North end of the needle will have but little error, as at S.E.
,,	West	,,	the North end of the needle will be *attracted* to the weather or nearest side.
,,	N.W.	,,	,, ,, the same.

These laws only hold good so long as the topsides, in the immediate vicinity of the Compass, retain their dominant polarity due to their original direction of build in Great Britain. If in South Magnetic Latitudes, a change of polarity takes place, the conditions of Heeling correspond to such change.

The maximum disturbance on Heeling in all these vessels is when their heads are (by disturbed Compass) magnetic North or South, and this disturbance vanishes when the head is East or West. This law of disturbance may be thus explained: when the vessel's head is North or South, on an even keel, (by disturbed Compass), the needle lies parallel to the topsides by their combined action, which neutralize each other; on Heeling, the nearest topside exercises its then dominant polarity at right angles to the direction of the needle, and hence the maximum error. With the ship's head East or West, whether on an even keel or heeling, either Pole of the Compass needle points directly to the topsides, and is consequently unaffected except in a vertical plane.

As the amount of disturbance on Heeling varies under the various conditions of direction of build, height of Compass, and breadth of ship or distance of topsides, added to the prevailing permanent or inductive magnetic condition of the latter and the deck-beams, each ship must have an individual character, to be determined only by experiment or observation at sea. There are, however, strong grounds for inferring that by a judicious position of the Compass, so as to ensure small errors while on an even keel, the errors arising from a ship's Heel will be so proportionally reduced, as not practically to affect the navigation of the ship in the hands of a prudent seaman.*

In the Northern Hemisphere, in ships built with their heads from about S.E., through *North*, to S.W. (the usual effect of the permanent Magnetism of the ship then conspiring with that of her vertical and transverse soft iron), the North point of the Compass needle, assuming the Compass to be on the upper deck and on the after portion of the ship, will, as a general rule, be drawn to windward, or to the high side of the ship; the nearer the ship's head was to North whilst building, the greater the error that may be expected; the effect being to throw the ship to windward of her supposed position when steering on Northerly courses, and to leeward on Southerly courses, the error decreasing as the Equator is approached, and small, perhaps of a contrary name, in the Southern Hemisphere.

In ships built with their heads from about S.E., through *South*, to S.W. (the usual effect of the permanent Magnetism, and that of the transverse, &c., soft iron being then contrary to each other) the North end of the Compass needle may be drawn to leeward, depending upon whether the vertical force of the permanent Magnetism, or that of the induced Magnetism of transverse and vertical soft iron, predominates, but the error would then, as a general rule, be small in these latitudes, and large in the Southern Hemisphere.

The Heeling error may be small or large, depending greatly upon the position of the Compass—it has been known to exceed 2° for every degree of Heel of the ship—and is directly proportional to the amount of Heel. Consequently, if the error at North or South for 1° of Heel is known, the error for any other direction of the ship's head, and amount of Heel, can be found by the usual methods.

Serious changes, however, frequently take place in the character and amount of the Heeling error as the ship changes her Magnetic Latitude. In the first place, from the vertical force arising from the permanent Magnetism of the ship, the error from which is greatest in high latitudes, diminishes until the Equator is reached, where it is least, and increases again in the opposite Hemisphere, but still retaining the same name; and in the second place, from vertical induction in vertical soft iron, and transverse soft iron generally (such as beams, &c.), the error from which is greatest in high latitudes, diminishes until the Equator is reached, where it becomes nil, and increases again (but of an opposite name) as the vessel recedes from the Equator in the opposite Hemisphere. It is difficult, therefore, to predict with any great accuracy the change that will take place, observations at every possible opportunity being the only reliable safeguard.

Mariners are further warned that the adjustment of Compasses by magnets, soft iron, &c., which is for bringing the error within manageable limits, and for equalising the directive force of the needle, must only be considered approximate for the latitude in which the adjustment was made, and they should lose no opportunity of verifying the error, both in port and at sea, as it is usually constantly changing from numerous causes, as before explained, the chief amongst which are Heeling, change of latitude, change of cargo, collision, after repairs, and from the ship remaining with her head in one direction for a length of time, &c.

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* "Reduction and Discussion of the Deviations of the Compass," by Fred. J. Evans, R.N., in the "Philosophical Transactions," 1860, part ii., pages 334—358.

One error very difficult to adjust is that caused by the *Sub-permanent Magnetism*, acquired by an iron vessel lying for a long time on one course, or in dock, this error having, in some cases, amounted to 10°, after lying on one course for 6 or 7 days. After steering for some time on *Westerly* courses, you may expect Westerly error if the course be changed to North, or Easterly error if it be changed to South. After steering for some time on an *Easterly* course, you may expect Easterly error if the course be changed to North, and Westerly error if it be changed to South.

The *Permanent Magnetism* is also liable to change in a new iron ship, and it is recommended, that after launching, she should lie with her head in the opposite direction to that in which she was built.

In some regions, such as near Cape St. Francis (Labrador), Iceland, and the Isles de Los, the Compass is liable to be greatly deranged by local influence. Magnetic Observations, made on the French cruiser *Allier* in 1883, when off the shores of Iceland, showed that the Local Deviation sometimes amounts to as much as 20° or 30°. Its influence generally ceases at 5 or 6 miles from the coast, but near Mount Sneefelds, Thorbak Bay, Cape Reikianæs, Westman Islands, and particularly on that part of the East coast between Papey, Skraden, and Hvalsbak Islands, the influence of the land extended as far as 20 and 30 miles seaward.

From the foregoing it will be seen, that for the purposes of computing the Deviation of the steering Compasses, caused by the iron used in the construction of the vessel, an Azimuth Compass is employed as a Standard, placed on the mid-ship line, as far as possible from any vertical objects of iron, such as masts, funnels, davits, and stanchions, and no iron of any kind allowed within 5 feet of it. It should also be kept at a distance from any electric lighting machinery, and double wires should always be used for leads. Where the electric light is used on a ship, it is also advisable to find by experiment what is the effect on the Compasses; by day they may be correct, but at night, when the dynamo is at work, the Compasses may be affected to the extent of several degrees.

It is unnecessary here to describe the process of swinging a ship for the Deviation of her Compasses, but this operation must not be performed till her cargo is stowed, and she is in all respects ready for sea. If the voyage should lead the vessel over a large extent of latitude, such as in passing from the Northern to the Southern Hemisphere, or vice versa, the original Deviation Tables will become incorrect, and new observations will be necessary.

8.—REMARKS ON THE BAROMETER.

By the late Admiral FitzRoy, F.R.S.[*]

The words on the scales of Barometers should not be so much regarded for weather indications, as the rising or falling of the mercury. For if it stand at *Changeable*, and then rise towards *Fair*, it presages a change of wind or weather, though not so great as if the mercury had risen higher; and, on the contrary, if the mercury stand above *Fair* and then fall, it presages a change, though not to so great a degree as if it had stood lower; besides which, the direction and force of wind are not in any way noticed. It is not from the point at which the mercury may stand that we are alone to form a judgment of the state of the weather, but from its *rising* or *falling;* and from the movements of immediately preceding days, as well as hours, keeping in mind effects of change of *direction*, and dryness, or moisture, as well as alteration of force or strength of wind.

In Western Europe, towards the higher latitudes, the quicksilver ranges, or rises and falls, nearly three inches—namely, between about thirty inches and eight-tenths (30·8), and less than twenty-eight inches (28·0) on extraordinary occasions; but the usual range is from about thirty inches and a half (30·5) to about twenty-nine inches. Near the Line, or in Equatorial regions, the range is but a few tenths, except in storms, when it sometimes falls to twenty-seven inches.

The sliding-scale (vernier) divides the tenths into ten parts each, or hundredths of an inch. The number of divisions on the vernier exceeds that in an equal space of the fixed scale by one.

If the Barometer has been about its ordinary height, say near thirty inches, at the sea-level,[†] and is steady, or rising—while the Thermometer falls, and dampness becomes less—north-westerly, northerly, or north-easterly wind—or less wind—may be expected.

On the contrary, if a fall takes place, with a rising Thermometer and increased dampness, wind and rain (or snow) may be expected from the south-eastward, southward, or south-westward.

Exceptions to these rules occur when a north-easterly wind, with wet (rain or snow), is impending, before which the Barometer often rises (on account of the *direction* of the coming wind alone), and deceives persons who, from that sign only, expect fair weather.

When the Barometer is rather below its ordinary height, say, near twenty-nine inches and a half (at the sea-level *only*), a rise foretells less wind, or a change in its direction toward the northward—or less wet; but when the mercury has been low, say near twenty-nine inches, the first rising usually precedes and foretells strong wind—(at times heavy squalls)—

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[*] It must be remembered that these remarks were written previous to the discovery of the Cyclonic and Anti-cyclonic systems of Storms (page 198), which cross our islands. They are, however, quite in agreement with these systems.

[†] It stands lower, about one-tenth of an inch for each 100 feet of height directly upwards, or vertically, above the sea, where its average height, in England, is 29·94 inches (at 32° F.).

from the north-westward, northward, or north-eastward, *after* which violence a rising glass foretells improving weather, if the Thermometer falls. But, if the warmth continue, probably the wind will back (shift against the sun's course), and more southerly, or south-westerly wind will follow.*

The most dangerous shifts of wind, and the heaviest northerly† gales, happen after the mercury first rises from a very low point.

Indications of approaching changes of weather, and the direction and force of winds, are shown less by the height of mercury in the tube, than by its falling or rising. Nevertheless, a height of about thirty inches (at the level of the sea) is indicative of fine weather and moderate winds.

The Barometer is said to be *falling* when the mercury in the tube is sinking, at which time its upper surface is *sometimes* concave or hollow. The Barometer is *rising* when the mercurial column is lengthening; its upper surface being then, as usual, convex or rounded.‡

A rapid rise of the Barometer indicates unsettled weather. A slow rise, or steadiness, with dryness, shows fair weather.

A considerable and rapid fall is a sign of stormy weather and rain. Alternate rising and sinking show very unsettled weather.

The greatest depressions of the Barometer are with gales from the S.E., southward, or S.W.; the greatest elevations, with winds from the N.W., northward, or N.E.

Although the Barometer generally falls with a southerly and rises with a northerly wind, the contrary *sometimes* occurs; in which cases the southerly wind is dry and the weather fine; or the northerly wind is wet and violent.

When the Barometer sinks considerably, high wind, rain, or snow will follow; the wind will be from the northward, if the Thermometer is low (for the season)—from the southward if the Thermometer is high.

Sudden falls of the Barometer, with a westerly wind, are sometimes followed by violent storms from N.W. or North.

If a gale sets in from the eastward or S.E., and the wind veers by the South, the Barometer will continue falling until the wind becomes S.W., when a comparative lull may occur, after which the gale will be renewed; and the shifting of the wind towards the N.W. will be indicated by a fall of the Thermometer as well as a rise of the Barometer.

Three things appear to affect the mercury in a Barometer:—

1. The direction of the wind—the N.E. wind tending to raise it most—the S.W. to lower it the most, and winds from points of the compass between them proportionally as they are nearer one or the other extreme point; N.E. and S.W. may therefore be called the wind's extreme bearing.

The range, or difference of height of the mercury, due to change of direction only, from one of these bearings to the other (supposing strength or force, and moisture, to remain the same), amounts in these latitudes to about half an inch (shown by the Barometer as read off).

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* In an Aneroid, a metallic, or a wheel Barometer, the motion of the hand should correspond to that of the mercury in an independent instrument.

† Southerly in South latitude.

‡ In the best columns, those of standards for example, no concavity is seen at any time.

2. The amount, taken by itself, of vapour, moisture, wet, rain, or snow, in the wind (direction and strength remaining the same), seems to cause a change amounting, in an extreme case, to about half an inch.

3. The strength or force alone of wind from any quarter (moisture and direction being unchanged) is preceded or foretold by a fall or rise, according as the strength will be greater or less, ranging in extreme cases to more than two inches.

Hence, supposing the three causes to act together—in extreme cases—the mercury might range from about thirty-one (30·8) inches to near twenty-seven (27·1) inches, which has happened occasionally.

Generally, however, as the three act much less strongly, and are less in accord, ordinary varieties of weather (the wind varying between S.W. and N.W., with more or less cloudiness or rain) occur much more frequently than extreme changes.

Another general rule requires attention; which is, that the wind usually veers, shifts, or goes round *with the sun* (right-handed in the northern regions, left-handed in the southern parts of the world); and that, when it does not do so, or backs, more wind or bad weather may be expected instead of improvement.

In a Barometer the mercury begins to rise occasionally before the conclusion of a gale, sometimes even at its commencement, as the equilibrium of the atmosphere begins to be restored. Although the mercury falls lowest before high winds, it frequently sinks considerably before heavy rain. The Barometer falls, but *not always*, on the approach of thunder and lightning, or when the atmosphere is highly charged with electricity.* Before and during the earlier part of serene and settled weather, the mercury commonly stands high, and is stationary.

Instances of fine weather, with a low glass, occur exceptionally, but they are always preludes to a duration of wind or rain, *if not both.*

After very warm and calm weather, rain or a storm is likely to occur; or at any time when the atmosphere has been *heated* much above the usual temperature of the season.

Allowance should invariably be made for the previous state of the column during some days, as well as hours, because its indications may be affected by remote causes, or by changes close at hand. Some of these changes may occur at a greater or less distance, influencing neighbouring regions, but not visible to each observer whose Barometer feels their effect.

There may be heavy rains or violent winds beyond the horizon and the view of an observer, by which his instruments may be affected considerably, though no particular change of weather occurs in his immediate vicinity.

It may be repeated, that the longer a change of wind or weather is foretold by the Barometer before it takes place, the longer the presaged weather will last; and, conversely, the shorter the warning, the less time, whatever causes the warning, whether wind or a fall of rain or snow, will continue.

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* Thunder clouds sometimes rise and spread against the wind (lower current). It is probable that there is a meeting, if not a conflict of air currents, electrically different, whenever lightning is seen. Their meeting, when the new one advances from the *polar* region, does not affect the Barometer, except in oscillation, which is very remarkable at the time.

Sometimes severe weather from an Equatorial direction, not lasting long, may cause no great fall of the Barometer, because followed by a *duration* of wind from Polar regions; and at times it may fall considerably with Polar winds and fine weather, apparently against these rules, because a *continuance* of Equatorial wind is about to follow. By such changes as these one may be misled, and calamity may be the consequence if not thus forewarned.

This ends Admiral FitzRoy's remarks: what follows is taken chiefly from "Instructions in the use of Meteorological Instruments" issued by the Meteorological Office.

Further Remarks.—The Barometer was invented in 1643 by Torricelli, consequent on attempts to raise water by pumps from a deep well in Florence; by no method could the water be made to rise higher in the pump tube than about 32 feet. Experimenting on this, he found mercury in a short tube more manageable for showing changes in atmospheric pressure.

Various fluids have been used for filling the tube, but those giving off vapour at low temperatures are very unsuitable, the space above the fluid being far from a vacuum. Mr. J. B. Jordan invented a glycerine Barometer, having a length of about 32 ft., showing slight variations in pressure very clearly. For scientific purposes, however, mercury is the only suitable fluid for Barometer tubes.

The Barometer now recommended by the Meteorological Office for use at sea, is known as the Kew Marine Barometer. Each of these instruments is tested at the Kew Observatory, and the scales correctly marked, the errors due to the capacity of the cisterns, varying size of the tube, &c., having been allowed for. By means of the *Vernier*, the height of the mercurial column may be read to one-thousandth part of an inch. For the prevention of *pumping*, or oscillation of the column of mercury, the lower part of the tube has a contracted bore down to the cistern, and the upper part as far as the scale portion is, of even a finer bore. In the larger bore, between these two fine bores, there is inserted a *pipette*, or funnel, spout downwards, the object of this being to intercept any air which, creeping up the sides of the tube, would, by getting into the vacuum at the top of the tube, completely upset the working of the instrument. The best test for moisture or for particles of air, between the column of mercury and the side of the glass tube, is the magnifying glass, by means of which the existence of such matter is easily detected.

Sometimes, though very rarely, a particle of dirt, or a bubble of air, lodges in the very fine contraction of the tube of a marine Barometer, and completely stops the action of the instrument. Whenever, therefore, a marine Barometer becomes stationary or inactive, when it evidently ought to be moving under the influence of atmospheric changes, there being no evidence of fracture of the glass, the cause may be surmised to be of this nature. It should then be taken down, the mercury allowed to fill the tube, and the instrument put aside, in an *inverted* position, for a few hours. On replacing it, the cause of the stoppage will generally be found to have been removed to a part of the tube where it can do no harm.

Barometers when in use at sea are slung in gimbals, and suspended from arms at least a foot long, so as to be perfectly free to assume the vertical position under every movement of the ship, and at the same time to keep clear of the bulkhead against which the arm is fastened.

Care should be taken that no readings from a Barometer which is not hanging truly vertically should ever be recorded. Such readings will always be too high in proportion to the degree of obliquity.

At Kew, all marine Barometers are rejected of which the index error at the ordinary pressure is greater than 0·015 inch, or the capacity error greater than 0·004 inch, or for which the mercury takes less than 3, or more than 6, minutes to fall from the height of 1·5 inch, to that of 0·5 inch above the existing pressure. This latter condition is to ensure the efficiency of the contraction as a provision against "pumping," as well as to prevent the danger of the Barometer being too sluggish from over-contraction.

Correction to be applied to Barometers, with Brass Scales extending from the Cistern to the top of the Column, to reduce the observation to 32° F.

Temperature.	INCHES.															Temperature.
	24·0	24·5	25·0	25·5	26·0	26·5	27·0	27·5	28·0	28·5	29·0	29·5	30·0	30·5	31·0	
°	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	°
0	·061	·063	·064	·065	·067	·068	·069	·071	·072	·073	·074	·076	·077	·078	·080	0
10	·040	·041	·042	·042	·043	·044	·045	·046	·047	·047	·048	·049	·050	·051	·052	10
20	·018	·019	·019	·020	·020	·020	·021	·021	·021	·022	·022	·023	·023	·023	·024	20
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
30	·003	·003	·003	·004	·004	·004	·004	·004	·004	·004	·004	·004	·004	·004	·004	30
40	·025	·025	·026	·026	·027	·027	·028	·028	·029	·029	·030	·030	·031	·031	·032	40
50	·046	·047	·048	·049	·050	·051	·052	·053	·054	·055	·056	·057	·058	·059	·060	50
60	·068	·069	·070	·072	·073	·075	·076	·077	·079	·080	·082	·083	·085	·086	·087	60
70	·089	·091	·093	·095	·096	·098	·100	·102	·104	·106	·108	·109	·111	·113	·115	70
80	·110	·113	·115	·117	·119	·122	·124	·126	·129	·131	·133	·136	·138	·140	·143	80
90	·131	·134	·137	·140	·142	·145	·148	·151	·153	·156	·159	·162	·164	·167	·170	90
100	·153	·156	·159	·162	·165	·169	·172	·175	·178	·181	·184	·188	·191	·194	·197	100

Correction for Temperature, or Reduction to 32° Fahr.—When the Barometer is at a Temperature below 32°, the correction is (+), *i.e.* to be added, and when it is above 32° it is (—), *i.e.* to be subtracted. Thus supposing the mercury in the Barometer tube to stand at 28·5 inches, and the attached Thermometer registers the Temperature of the tube and case (not of the surrounding air) as 50°, the correction, according to the above Table, of ·055 inch, must be subtracted from 28·5 inches, to reduce the reading to the Standard Temperature of 32°. In taking an observation, the attached Thermometer should be read first, in case of its being affected by the heat of the observer's person. Brass is considered the most suitable metal for Barometer cases.

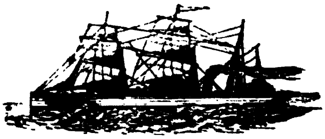
The Aneroid Barometer is an instrument which has come into extensive use, owing to its convenient size and portability. In the Aneroid, atmospheric pressure is measured by its effect in altering the shape of a small, hermetically sealed, metallic box, from which almost all the air has been withdrawn, and which is kept from collapsing by a spring. The top of the box is corrugated. When the atmospheric pressure rises above the amount which was recorded when the instrument was made, the top is forced inwards; and *vice versa*, when the pressure falls below that amount, the top is pushed outwards by the spring. These motions are transferred by a system of levers and springs to a pointer, which moves on a dial like that of a wheel-barometer.

It is at once evident that the instrument must be graduated experimentally, as it cannot measure pressure absolutely, but affords indications relatively to a mercurial Barometer, its sensibility depending, *inter alia*, on the quality of the metal of which the box is made.

Aneroids are very sensitive, but unfortunately they do not preserve their accuracy. If a table of corrections be determined for an Aneroid, it will be found that after a time the latter has undergone some change, and that the values of the corrections will require alteration, so that re-comparison with a Standard Barometer will be necessary (see page 108). In every case of such comparison the readings of the mercurial Barometer should be reduced to 32°.

A most serious objection to the scientific utility of these instruments is their liability to injury, owing to rust, or to the alteration of force in the springs used in their construction. However, for the reasons above stated, the Aneroid is especially suitable for fishermen and pilots, or seafaring persons employed in boats or small coasting vessels, in which there is not space to suspend a Barometer.

For further information, on the practical use of the Barometer, reference should be made to the Section on "The Motions and Pressure of the Atmosphere," pages 108—124.



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